GE Medical Systems

Technical Publications

Direction 2219419–100

Revision 1

ADVANTAGE SIM 4.0 Conformance Statement for DICOM V3.0

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REVISION HISTORY

REV	DATE	REASON FOR CHANGE
0	June 17, 1998	Modifications for Advantage Sim 4.0 (including addition of Section 8)
1	September 10, 1998	M4 release

LIST OF EFFECTIVE PAGES

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SECTION 1 – INTRODUCTION

1–0 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 GEMS equipment compliance to the DICOM requirements for the implementation of Networking features.

Section 3, *Secondary Capture Information Object Implementation*, which defines the GEMS equipment compliance to DICOM requirements for the implementation of a Secondary Capture information object.

Section 4, *RT Image Information Object Implementation*, which defines the GEMS equipment compliance to DICOM requirements for the implementation of an RT Image information object.

Section 5, *RT Structure Set Information Object Implementation*, which defines the GEMS equipment compliance to DICOM requirements for the implementation of an RT Structure Set information object.

Section 6, *RT Plan Information Object Implementation*, which defines the GEMS equipment compliance to DICOM requirements for the implementation of an RT Plan information object.

Section 7, *GE Private DICOM RT Plan Information Object Implementation*, which defines the technical details of the GE Private DICOM RT Plan Information Object Definition (IOD) created by Advantage Sim.

Section 8, *CT Image Information Object Requirements*, which defines the requirements for CT Images used as input to Advantage Sim.

1–1 Overall DICOM Conformance Statement Document Structure

The Documentation Structure of the GEMS Conformance Statements and their relationship with the DICOM v3.0 Conformance Statements is shown in Illustration 1–1.

This document specifies the DICOM v3.0 implementation for the Advantage Sim application. It forms part of the following document set:

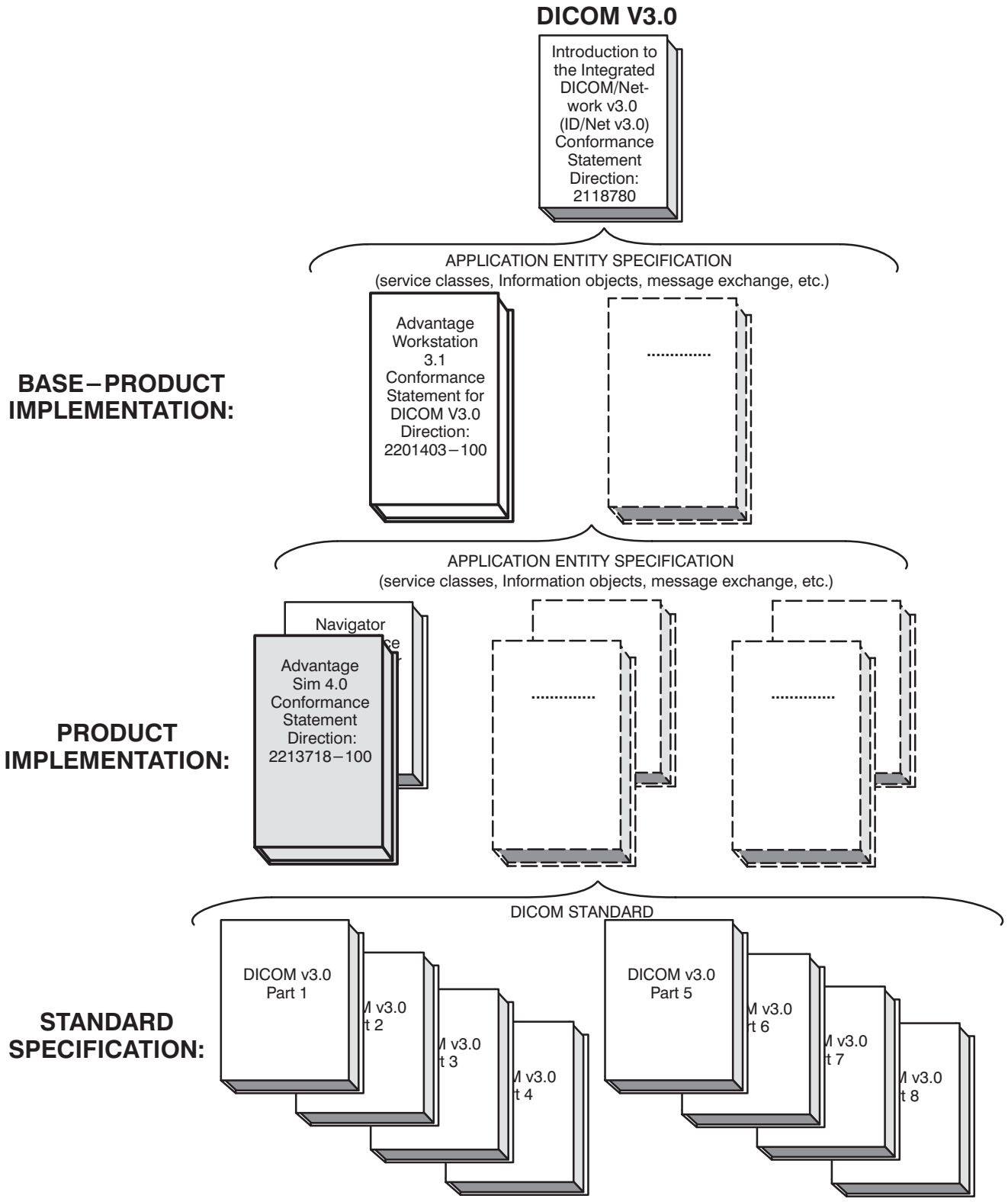
ADVANTAGE SIM 4.0
Conformance Statement
Direction .....# 2213718–100.

This DICOM Conformance Statement documents the DICOM compatibility of the Advantage Sim application which is not already provided by the base platform application, Advantage Workstation. The DICOM compatibility of this base application is in turn described in the document:

ADVANTAGE WORKSTATION 3.1
Conformance Statement for DICOM V3.0
Direction .....# 2201403–100.

Those sections of the Advantage Sim Conformance Statement which have been modified with respect to the Workstation Conformance Statement are included in the current document. The reader should refer to the Advantage Workstation Conformance Statement for all sections not found in the current document.

ILLUSTRATION **1–1**
DOCUMENTATION STRUCTURE



The above DICOM Conformance Statements document the DICOM Conformance Statement and Technical Specification required to interoperate with the GEMS DICOM v3.0 network interface. Introductory information, which is applicable to all GEMS DICOM v3.0 Conformance Statements, is described in the document:

Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0)
Conformance Statement
Direction .....# 2118780.

This Introduction familiarizes the reader with DICOM terminology and general concepts. It should be read prior to reading the individual products' GEMS Conformance Statements.

The GEMS 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 v3.0 Part 8 Standard.

For more information including Network Architecture and basic DICOM concepts, please refer to the *Introduction.*

Copies of the Standard may be obtained by written request or phone by contacting:

NEMA Publication
1300 North 17th Street
Suite 1847
Rosslyn, VA 22209
USA
Phone: (703) 841–3200

1–2 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 Standards and with the terminology and concepts which are used in those Standards.

If readers are unfamiliar with DICOM terminology they should first refer to the document listed below, then read the DICOM Standard itself, prior to reading this Conformance Statement document.

Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0)
Conformance Statement
Direction .....# 2118780.

1–3 Scope and Field of Application

It is the intent of this document, in conjunction with the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780,* and the *Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction: 2201403–100* to provide an unambiguous specification for GEMS implementations. This specification, called a Conformance Statement, includes a DICOM v3.0 Conformance Statement and is necessary to ensure proper processing and interpretation of GEMS medical data exchanged using DICOM. The GEMS Conformance Statements are available to the public.

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

Included in this Conformance Statement are the Module Definitions which define all data elements used by this GEMS implementation. If the user encounters unspecified private data elements while parsing a GEMS Data Set, the user is well advised to ignore those data elements (per the DICOM v3.0 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 retransmit all of the private data elements which are sent by GEMS devices.

1–4 Important Remarks

The use of these DICOM Conformance Statements, in conjunction with the DICOM v3.0 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 and radiotherapy 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 or therapy data once it has crossed the interface between the GE imaging or radiotherapy equipment and the non-GE device and the stability of the image or radiotherapy data for the intended applications.
  Such a validation is required before any clinical use (diagnosis and/or treatment) is performed. It applies when images and radiotherapy data acquired on GE imaging equipment are processed/displayed on a non–GE device, as well as when images and radiotherapy data 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 v3.0 Standard. DICOM v3.0 will incorporate new features and technologies and GE may follow the evolution of the Standard. The GEMS protocol is based on DICOM v3.0 as specified in each Conformance Statement. Evolution of the Standard may require changes to devices which have implemented DICOM v3.0. **In addition, GE reserves the right to discontinue or make changes to the support of communications features (on its products) reflected on 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.
- **To be informed of the evolution of the implementation described in this document, the user is advised to regularly check the GE Internet Server, accessible via anonymous ftp (GE Internet Server Address: ftp.med.ge.com, 192.88.230.11)**

- **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 or radiotherapy equipment performance and/or function.

1–5 References

A list of references which is applicable to all DICOM v3.0 Conformance Statements is included in the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780.*

The information object implementation refers to DICOM PS3.3–1998 (Information Object Definitions).

1–6 Definitions

A set of definitions which is applicable to all DICOM v3.0 Conformance Statements is included in the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780.*

A set of definitions which is applicable to radiotherapy is included in DICOM PS3.3–1998 (Information Object Definitions).

1–7 Symbols and Abbreviations

A list of symbols and abbreviations which is applicable to all DICOM v3.0 Conformance Statements is included in the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780.*

A set of symbols and abbreviations which is applicable to radiotherapy is available in CEI/IEC 1217: 1996 (Radiotherapy equipment – Coordinates, movements and scales).

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SECTION 2 – NETWORK CONFORMANCE STATEMENT

2–0 Introduction

This section of the DICOM Conformance Statement specifies the compliance to DICOM conformance requirements for the relevant **Networking** features on this GEMS product. Those sub–sections which are different from the document *Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction 2201403–100* appear here. Note that the format of this section strictly follows the format defined in DICOM Standard PS 3.2 (Conformance). Please refer to that part of the standard while reading this section.

Please also note the details of the DICOM conformance related to other Information Objects supported by this product are included in subsequent sections of this DICOM Conformance Statement.

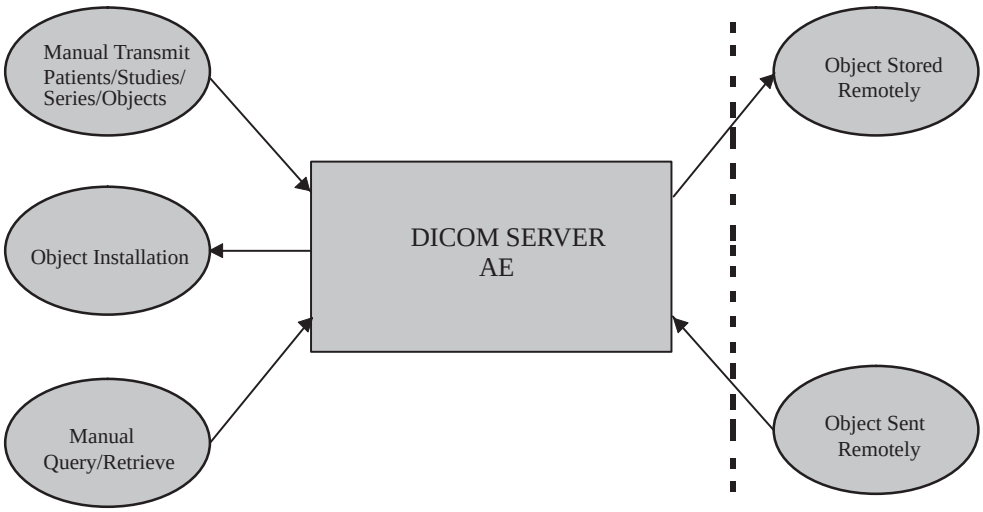
Advantage Sim is a radiotherapy virtual simulation application which is installed on the same hardware platform as the base application, Advantage Workstation. This base application is a Networked Medical Imaging Console dedicated to Examination Review and Diagnosis. The workstation uses DICOM services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

2–1 Implementation Model

2–1–1 Application Data Flow Diagram

The Basic and Specific Application models for this device are shown in Illustration 2–1.

ILLUSTRATION **2–1**
DICOM SERVER AE APPLICATION MODEL



Note: Please refer to the document *Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction 2201403–100* for Media Storage and Network Print Management SCU Conformance Statements.

The DICOM SERVER Application Entity (AE) is an application which handles DICOM protocol communication. The DICOM SERVER AE is automatically brought up when the Advantage Workstation is powered on.

All remote DICOM AE's must be manually configured on the Advantage Workstation, by an Operator or by a field engineer.

The DICOM SERVER AE is invoked by the following Real World Activities:

- Manual Transmit Patients/Studies/Series/Objects from the Advantage Workstation to a Remote Host.

For this operation, the operator selects patients, studies, series, or objects on the console browser and then sends the selected patients, studies, series, or objects to one or several remote DICOM AEs by drag and drops on the icons that represent the desired remote AEs.

The declaration of a remote DICOM AE is done through a specific menu (known as the NETWORK MANAGEMENT menu).

The visualization of the transfer status is done on a specific message window.

- Objects Sent Remotely from a Remote Host to the Advantage Workstation

When objects are installed in the local database, they are displayed in the Advantage Workstation local browser.

- Manual Query/Retrieve

For this operation, the operator queries a remote database to obtain a list of data at Patient/Study/Series/Object levels by clicking on the icon that represents the desired remote DICOM AE. Once the remote browser is displayed, the operator can retrieve from the remote DICOM AE the SOP Classes supported by Advantage Workstation.

The query is selective, based on criteria described below in this document.

2–1–2 Functional Definition of AEs

The DICOM SERVER AE initiates the following operations:

- Access to patient demographics and pixel data in the local database.
- Building of a DICOM format data set.
- Initiation of a DICOM association to send DICOM SOP Class instances to a remote DICOM AE.

Note: Advantage Sim *creates* the following DICOM object types: SC Image, RT Image, RT Structure Set, RT Plan, and GE Private DICOM RT Plan.

- Initiation of a DICOM association to ask for remote patient demographics.
- Initiation of a DICOM association to ask for transmission of DICOM SOP Class instances from a Remote Host to the Advantage Workstation.

The DICOM SERVER AE waits for and answers the following association requests from a remote AE:

- DICOM associations transmitting DICOM SOP Class instances to be stored on the Advantage Workstation.
- DICOM associations transmitting the Verification SOP Class to the Advantage Workstation.

2–1–3 Sequencing of Real–World Activities

Not Applicable

2–2 AE Specifications

2–2–1 DICOM SERVER AE Specification

For use by radiotherapy equipment accepting data from the Advantage Sim product, the DICOM SERVER Application Entity provides Standard Conformance to the following classes as an **SCU**:

SOP Class Name	SOP Class UID
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5
GE Private DICOM RT Plan Storage	1.2.840.113619.4.5.249
SC Image Storage (Advantage Sim implementation)	1.2.840.10008.5.1.4.1.1.7
CT Image Storage (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.1.2
Patient Root Query/Retrieve Information Model – MOVE (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.2.1.2
Study Root Query/Retrieve Information Model – FIND (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.2.2.1
Study Root Query/Retrieve Information Model – MOVE (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.2.2.2

Note: C–FIND is done using the Study Root Information Model.

Note: C–MOVE is done using either the Patient Root Information Model (when the operator asks to retrieve different patient folders at one time), or the Study Root Information Model (in all other cases).

For use by the Advantage Sim product, the DICOM SERVER Application Entity provides Standard Conformance to the following classes as an **SCP**:

SOP Class Name	SOP Class UID
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1
SC Image Storage (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.1.7
CT Image Storage (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.1.2

In addition to the above classes, the DICOM SERVER Application Entity also provides Standard Conformance to the classes described in Section 2.3.1 of *Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction 2201403–100.*

2–2–1–1 Association Establishment Policies

2–2–1–1–1 General

The DICOM Application Context Name (ACN), which is always proposed, is:

Application Context Name	1.2.840.10008.3.1.1.1

The Maximum Length PDU negotiation is included in all association establishment requests.

The Maximum Length PDU for an association initiated by the DICOM SERVER AE is by default:

Maximum Length PDU (default)	16 Kbytes

Note: 0 as PDU Length is not supported in this implementation.

Note: Maximum Length PDU can be configured at installation time.

The SOP class Extended Negotiation is not supported.

The maximum number of Presentation Context Items that will be proposed is 14.

Note: This number can evolve when applications are added on top of Advantage Workstation, or in particular configurations.

The user information items sent by this product are:

- Maximum PDU Length
- Implementation UID

2–2–1–1–2 Number of Associations

The DICOM SERVER AE will initiate only one DICOM association at a time to perform an DICOM storage operation as an SCU to a Remote Host AE.

The DICOM SERVER AE can have a maximum of 4 DICOM associations open simultaneously to receive an object or respond to an echo.

The DICOM SERVER AE will initiate only one DICOM association at a time to perform a Query/Retrieve operation with a Remote Host AE.

2–2–1–1–3 Asynchronous Nature

Asynchronous mode is not supported. All operations will be performed synchronously.

2–2–1–1–4 Implementation Identifying Information

The Implementation UID for the Advantage Workstation 3.1 DICOM v3.0 Implementation, used for network transfer of DICOM RT objects is:

Advantage Workstation 3.1 Implementation UID	1.2.840.113619.6.59

Note: The Implementation UID for the Advantage Sim 4.0 is 1.2.840.113619.6.68. This UID appears in the DICOM File Meta–information used for Media Storage, but is overridden by the Advantage Workstation implementation when transferring objects via network.

2–2–1–1–5 Real–World Activity: Manual Transmit of Patients/Studies/Series/Objects

2–2–1–1–5–1 Associated Real–World Activity

The operator selects in the BROWSER one or several Patient Folders/Studies/Series/Objects to be sent. Then, the user can either drag–and–drop the selection on the icon representing the Remote DICOM AE, or click on the “push” icon and select a remote DICOM AE in the list of remote hosts.

This operation will cause

- The Advantage Workstation to build DICOM object(s) from its data.
- The DICOM SERVER AE to initiate a DICOM association, and negotiate with the Remote AE an appropriate Abstract and Transfer Syntax.
- The DICOM SERVER AE to emit C–STORE command to send the object(s), if the negotiation is successful.

2–2–1–1–5–2 Association Initiation Policy

The DICOM SERVER AE initiates a new association for pushing Patient Folders (or Studies/Series/Objects) selected by the operator to a remote DICOM AE. This association corresponds to one Real–World Activity:

- Manual Transmit Patients/Studies/Series/Objects.

Note: The Length to End field (0000, 0001) is sent in this implementation.

2–2–1–1–5–3 Proposed Presentation Contexts

In addition to the non–radiotherapy Presentation Contexts described in Section 2.3.1.1.5.3 of *Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction 2201403–100,* Advantage Sim proposes the following Presentation Contexts:

Presentation Context Table – Proposed					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Plan Storage (Standard Extended object – see 2–4–1–2)	1.2.840.10008.5.1.4.1.1.481.5	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
GE Private DICOM RT Plan Storage	1.2.840.113619.4.5.249	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
SC Image Storage (Advantage Sim implementation)	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
CT Image Storage (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

2–2–1–1–5–3–1 SOP Specific DICOM Conformance Statement for Storage SOP Classes

The following table describes processing of status codes received from a Storage SCP equipment:

Service Status	Status Codes	Further Meaning	Application Behavior When Receiving Status Code	Related Fields Processed
Refused	A7xx	Out of Resources	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0902)
	0122	SOP Class not supported	General warning message is logged. Association is not closed with Remote AE. Appropriate message is displayed to user.	(0000,0902)
Error	Cxxx	Cannot understand	General warning message is logged. Association is not closed with Remote AE. Appropriate message is displayed to user.	(0000,0901) (0000,0902)
	A9xx	Data Set does not match SOP Class	General warning message is logged. Association is not closed with Remote AE. Appropriate message is displayed to user.	(0000,0901) (0000,0902)
Warning	B000	Coercion of Data Elements	General warning message is logged. Association is not closed with Remote AE.	(0000,0901) (0000,0902)
	B007	Data Set does not match SOP Class	General warning message is logged. Association is not closed with Remote AE.	(0000,0901) (0000,0902)
	B006	Elements discarded	General warning message is logged. Association is not closed with Remote AE.	(0000,0901) (0000,0902)
Success	0000			None

Each C–STORE operation supports an “Association Timer”. This timer starts when the association request is sent and stops when the association is established. This timeout is configurable at installation time and defaults to 60 seconds.

Each C–STORE operation supports an “Operation Inactivity Timer”. This timer starts when a C–STORE request is emitted and is reset each time the C_STORE response is received, or when a subsequent C_STORE is received. This timeout is configurable at installation time and defaults to 180 seconds.

Each C–STORE operation supports an “Session Timer”. This timer starts when the association is established and stops when the association is ended. This timeout is configurable at installation time and defaults to 3600 seconds.

If any of the three above timers expires, the connection is aborted and the operation is considered to be failed.

2–2–1–1–6 Real–World Activity: Manual Query/Retrieve

2–2–1–1–6–1 Associated Real–World Activity

The operator can query a Remote database by clicking on the icon representing the Remote DICOM AE. A new BROWSER (known as REMOTE BROWSER) appears on the screen(s) upon successful query.

Then the operator can select in the REMOTE BROWSER one or several Patient Folders/Studies/Series/Objects, and can either drag and drop the selection onto the icon representing the Advantage Workstation, or click on the “Pull” icon to retrieve the selection to the Advantage Workstation database.

These operations will cause

- The DICOM SERVER AE to initiate a DICOM association.
- The DICOM SERVER AE to emit a C–FIND request to get a list of patients regarding criteria listed below, then to get the selected studies, series, or objects.
- The DICOM SERVER AE to emit a C–MOVE request to specify a selected list of Patient Folders/Studies/Series/Objects to be sent by the Remote Host to the Advantage Workstation.

Note: An option available on the Advantage Workstation known as the REMOTE VIEWER allows viewing of images stored remotely. The same operations as described in the previous step are performed, except that the images are stored temporarily rather than being declared physically in the Advantage Workstation database.

2–2–1–1–6–2 Association Initiation Policy

The DICOM SERVER AE initiates a new association for querying Patient Folders (or Studies/Series/Objects) on a remote DICOM AE. This association corresponds to one Real–World Activity:

- Manual Query/Retrieve

Note: The Length to End field (0000, 0001) is sent in this implementation.

2–2–1–1–6–3 Proposed Presentation Contexts

Presentation Context Table − Proposed					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Patient Root Q/R Information Model − MOVE	1.2.840.10008.5.1.4.1.2.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Study Root Q/R Information Model − FIND	1.2.840.10008.5.1.4.1.2.2.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Study Root Q/R Information Model − MOVE	1.2.840.10008.5.1.4.1.2.2.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

2–2–1–1–6–3–1 SOP Specific DICOM Conformance Statement for the Study Root Query/Retrieve Information Model FIND SOP Class

The following table describes processing of status codes received from a Query SCP equipment:

Service Status	Status Codes	Further Meaning	Application Behavior When Receiving Status Code	Related Fields Processed
Refused	A7xx	Out of Resources	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0902)
	0122	SOP Class not supported	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0902)
Failed	A900	Identifier does not match SOP Class	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0901) (0000,0902)
	Cxxx	Unable to process	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0901) (0000,0902)
Cancel	FE00	Matching terminated due to cancel	Association is closed with Remote AE. Appropriate message is displayed to user.	None
Success	0000	Matching is complete – no final Identifier is supplied		None
Pending	FF00	Matches are continuing – current match is supplied and any Optional Keys were supported in the same manner as Required Keys.		Identifier
	FF01	Matches are continuing – warning that one or more Optional Keys were not supported for existence and/or matching for this Identifier.		(0000,0901) (0000,0902)

The C–FIND SCU will only perform hierarchical query (no extended negotiation is supported).

Each C–FIND SCU supports an Association Timer, Operation Timer, and Session Timer (see previous section) that can be configured at installation time. These timers default to 60, 90, and 3600 seconds respectively.

The DICOM SERVER AE will parse each matching C_FIND_RSP reply and will abort the association if an entry does not contain a valid dataset.

2–2–1–1–6–3–2 SOP Specific DICOM Conformance Statement for the Patient Root Query/Retrieve Information Model MOVE SOP Class and Study Root Query/Retrieve Information Model MOVE SOP Class

Each C–MOVE operation supports an “Association Establishment Timer”. This timer starts when the association request is sent and stops when the association is established. This timer is set to 60 seconds by default.

The following table describes processing of status codes received from a Retrieve SCP equipment:

Service Status	Status Codes	Further Meaning	Application Behavior When Receiving Status Code	Related Fields Processed
Refused	A701	Out of Resources – unable to calculate number of matches	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0902)
	A702	Out of Resources – unable to perform sub–operations	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,1021) (0000,1022) (0000,1023)
	A801	Move destination unknown	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0902)
	0122	SOP Class not supported	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0902)
Failed	A900	Identifier does not match SOP Class	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0901) (0000,0902)
	Cxxx	Unable to process	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,0901) (0000,0902)
Cancel	FE00	Sub–operations terminated due to cancel	Association is closed with Remote AE. Appropriate message is displayed to user.	(0000,1020) (0000,1021) (0000,1022)
Warning	B000	Sub–operations complete – one or more failures	Association is not closed with Remote AE. No message is displayed to user.	(0000,1021) (0000,1022) (0000,1023)
Success	0000	Sub–operations complete – no failure		(0000,1021) (0000,1022) (0000,1023)
Pending	FF00	Sub–operations are continuing		(0000,1020) (0000,1021) (0000,1022) (0000,1023)

Each C–FIND SCU supports an Association Timer, Operation Timer, and Session Timer (see previous section) that can be configured at installation time. These timers default to 60, 90, and 3600 seconds respectively.

2–2–1–1–7 Real–World Activity: Object Installation

The DICOM SERVER AE accepts an association when it receives a valid association request from a DICOM Storage SCU.

2–2–1–1–7–1 Associated Real–World Activity

The DICOM SERVER AE waits for any associations. No operator action is required to receive an object.

2–2–1–1–7–2 Association Acceptance Policy

When the DICOM SERVER AE accepts an association, it will receive any objects transmitted on that association and store the objects on disk. Any Remote DICOM AE can send objects to the DICOM Server AE.

2–2–1–1–7–3 Accepted Presentation Contexts

In addition to the non–radiotherapy Presentation Contexts described in Section 2.3.1.1.7.3 of *Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction 2201403–100,* Advantage Sim proposes the following Presentation Contexts:

Presentation Context Table – Accepted					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
SC Image Storage (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
CT Image Storage (Advantage Workstation implementation)	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

2–2–1–1–7–3–1 SOP Specific DICOM Conformance Statement for all Storage SOP Classes

The following table describes status codes the application may send back to the SCU equipment after performing the requested storage:

Service Status	**Status Codes**	**Further Meaning**	**Application Behavior When Receiving Status Code**	**Related Fields Processed**
Refused	A7xx	Out of resources	Indicates that there was insufficient space or some other internal resource (e.g. memory) to store the object. User should attempt recovery by removing some objects from the Advantage Workstation database.	(0000,0902)
Error	0110	Processing failure	Indicates that an internal system call has failed while processing this object.	(0000,0902)
Success	0000			None

Each C–STORE SCP supports an Association Timer, Operation Timer, and Session Timer (see previous section) that can be configured at installation time. These timers default to 60, 180, and 3600 seconds respectively.

The DICOM Server AE conforms to the SOP's of the Storage Service Class at Level 2 (Full), as described in Section B.4.1 of PS 3.4 of the DICOM Standard.

Information Object Reception Phase

- If the DICOM SERVER AE fails to parse the received object, the error 0110 (Processing Failure) is returned to the C–STORE SCU.
- If the DICOM SERVER AE fails to install the received object into the local database, the error A700 (Out of Resources) is returned to the C–STORE SCU.

When a C–STORE operation is returned Successful to the C_STORE SCU, the object has been written to disk and declared in the local database. The object will then be accessed in the same manner as any other object by the applications on the Advantage Workstation.

When a C–STORE operation is returned Error to the C_STORE SCU, the object will be removed and a message will appear in the browser message log informing the user of a failure. A physical disk area may be specified by a GE Field Engineer to keep the object files which have not been installed.

Information Object Declaration Phase

If the object declaration is unsuccessful, a message will appear in the Message Log informing the user of the failure and the object file will be removed by default.

If the object declaration process finds that an element is not encoded according to the DICOM standard, it will fail to install the object and the file will be removed. A physical disk area may be specified by a GE field engineer to keep the object files not installed.

For image objects, the overlay planes (groups 60xx) are burnt into the pixel data and deleted from the original image. A Standalone Overlay image will have pixel data created from the overlay data which will be stored with the image. An image containing overlay planes must fulfill the following conditions:

- Overlay planes must be encoded in groups 6000 and 6002 (not embedded in image pixel data).
- Overlay planes must have the same size as the image.
- Bits Allocated (0028, 0100) for the image must be 16.

Note: Objects with empty Patient's Name (0010,0010) and Patient ID (0010,0020) fields are accepted into the Advantage Workstation database. However, there are restrictions on the use of these images by Advantage Sim (see Section 8).

Note: The rescale slope (0028,1053) field is ignored. This value is defaulted to 1.

Note: The Advantage Workstation Viewer measurement algorithm uses only Pixel Spacing (0028,0030). If Image Pixel Spacing (0018,1164) is filled instead, measurement will be reported in pixels instead of mm.

Note: All images are installed with the elements received, except for Window Center (0028,1050) and Window Width (0028,1051) which may be modified at installation.

Note: Standalone Overlay Storage SOP Class instances are formatted into Secondary Capture SOP Class instances when installed on Advantage Workstation.

Note: Only grayscale images are supported in Advantage Workstation.

Note: Modality LUT and VOI LUT are ignored by Advantage Workstation.

Note: Images with non–square pixels are not handled by Advantage Workstation or Advantage Sim.

Note: No optional (type 3) or possibly zero–length (type 2) data elements are required to be declared on Advantage Workstation. However, Advantage Sim requires some of these attributes to be defined (see Section 8).

2–2–1–1–7–4 Presentation Context Acceptance Criterion

Only known SOP Classes are accepted.

2–2–1–1–7–5 Transfer Syntax Selection Policies

The default transfer syntax for SOP Classes is always chosen (Implicit VR Little Endian: 1.2.840.10008.1.2).

2–3 Communication Profiles

2–3–1 Supported Communication Stacks (PS 3.8, PS 3.9)

DICOM Upper Layer (PS 3.8) is supported using TCP/IP.

2–3–2 OSI Stack

The OSI stack is not supported.

2–3–3 TCP/IP Stack

The TCP/IP stack is inherited from a UNIX Operating System.

2–3–3–1 API

Not applicable to this product.

2–3–3–2 Physical Media Support

DICOM is indifferent to the physical medium over which TCP/IP executes (e.g. Ethernet V2.0, IEEE 802.3, ATM, FDDI, Ethernet 100 Mb).

Note: For more information about the physical media available for Advantage Workstation, refer to the Product Data Sheet.

2–3–4 Point–to–Point Stack

Not applicable to this product.

2–4 Extensions/Specializations/Privatizations

2–4–1 Standard Extended/Specialized/Private SOPs

2–4–1–1 Private SOP Class GE DICOM RT Plan

See Section 7 of this document.

2–4–1–2 Standard Extended SOP Class RT Plan

See Section 6 of this document.

The RT Plan SOP Instances created by Advantage Sim contain two additional elements in the Beam Sequence (300A,00B0) contained within the RT Beams module (see Section 6–4–5–3 of this document). These two attributes are the Referenced SOP Class UID (0008,1150) and Referenced SOP Instance UID (0008,1155) of the GE Private DICOM Treatment Machine object used for the beam. These attributes have no meaning outside the Advantage Sim application, and are provided to resolve future issues of backward compatibility within the Advantage Sim product line. These attributes should be ignored by SCP implementations interpreting these objects.

2–4–2 Private Transfer Syntaxes

No private transfer syntaxes are negotiated.

2–5 Configuration

2–5–1 AE Title/Presentation Address Mapping

The Local AE Title is configurable. This must be configured by a GE Field Engineer during installation.

2–5–2 Configurable Parameters

The following fields are configurable for this AE (local):

- Local AE Title
- Local IP Address
- Local IP Netmask

The Local Listening Port Number is not configurable and set to 4006.

The following fields are configurable for every remote DICOM AE:

- Remote AE Title
- Remote IP Address
- Listening TCP/IP Port Number

A default router IP Address for all remote nodes can be configured.

- Remote Provider Type (Query/Retrieve Level supported by the Remote Host AE)

The following parameters are configurable:

- Association Establishment Timer
- Store, Find, Move Timers
- Inactivity Timers
- Maximum Length PDU

Note: All configuration must be performed by a GE Field Engineer.

2–6 Support of Extended Character Sets

Advantage Sim will support only the ISO_IR 100 (ISO 8859–1: 1987 Latin alphabet No 1, supplementary set) as extended character sets.

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SECTION 3 – SECONDARY CAPTURE INFORMATION OBJECT IMPLEMENTATION

3–0 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.

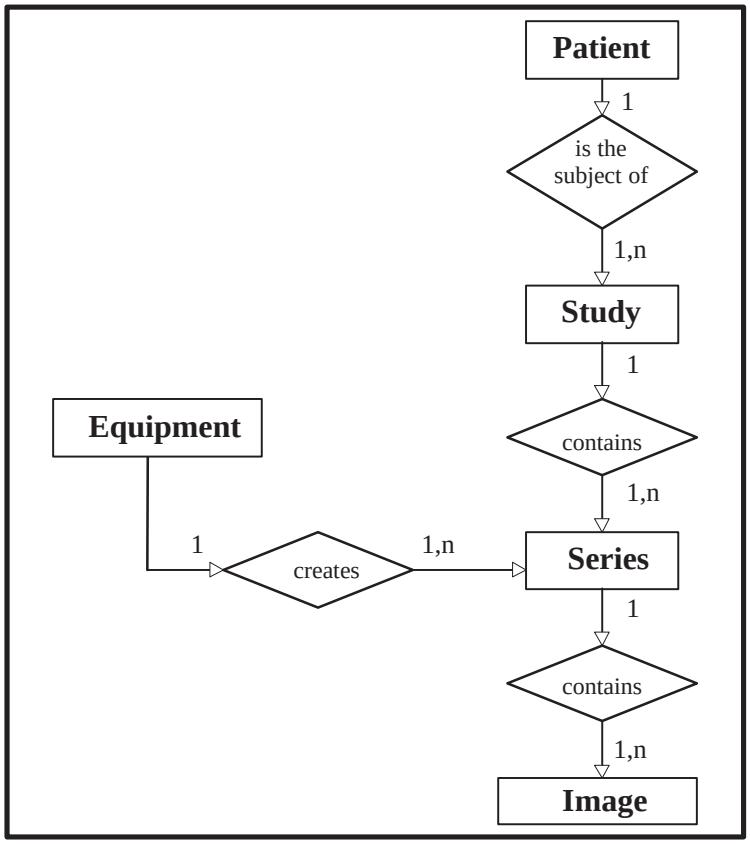
Note that the implementation described in this section relates to generation of SC Images by the Advantage Sim product only. The Advantage Sim application does not display SC Images directly, but relies on the Advantage Workstation product for this function. SC Image conformance for Advantage Workstation is described in a related document entitled *Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction 2201403–100.*

3–1 SC Image IOD Implementation

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

3–2 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.

3–2–1 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.

3–2–2 Advantage Sim Mapping of DICOM entities

DICOM entities map to the Advantage Sim entities in the following manner :

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

3–3 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.

TABLE 3–1
SC IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

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

3–4 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.

3–4–1 Patient Entity Modules

3–4–1–1 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
Patient's Birth Date	(0010,0030)	2	Duplicated from patient model images if present in those images, otherwise zero–length
Patient's Sex	(0010,0040)	2	Duplicated from patient model images if present in those images, otherwise zero–length

3–4–2 Study Entity Modules

3–4–2–1 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 if present in those images, otherwise zero–length
Accession number	(0008,0050)	2	Duplicated from patient model images if present in those images, otherwise zero–length

3–4–3 Series Entity Modules

3–4–3–1 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	
Series Description	(0008,103E)	3	'SC Image (Adv Sim)'

3–4–4 Equipment Entity Modules

3–4–4–1 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	'4.0.x' (single–valued)

3–4–4–2 SC Equipment

Attribute Name	Element Tag	TP	Notes
Conversion Type	(0008,0064)	1	'WSD'
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	'4.0.x'

3–4–5 Image Entity Modules

3–4–5–1 General Image

Attribute Name	Element Tag	TP	Notes
Image Number	(0020,0013)	2	
Patient Orientation	(0020,0020)	2C	Zero–length
Image Date	(0008,0023)	2C	
Image Time	(0008,0033)	2C	
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

3–4–5–2 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 Advantage Sim 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

3–4–5–3 SC Image

Attribute Name	Element Tag	TP	Notes
Date of Secondary Capture	(0018,1012)	3	
Time of Secondary Capture	(0018,1014)	3	

3–4–5–4 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 ‘1.2.840.113619.2.68’
Specific Character Set	(0008,0005)	1C	‘ISO_IR 100’
Instance Creation Date	(0008,0012)	3	
Instance Creation Time	(0008,0013)	3	
Instance Creator UID	(0008,0014)	3	‘1.2.840.113619.6.68’

SECTION 4 – RT IMAGE INFORMATION OBJECT IMPLEMENTATION

4–0 Introduction

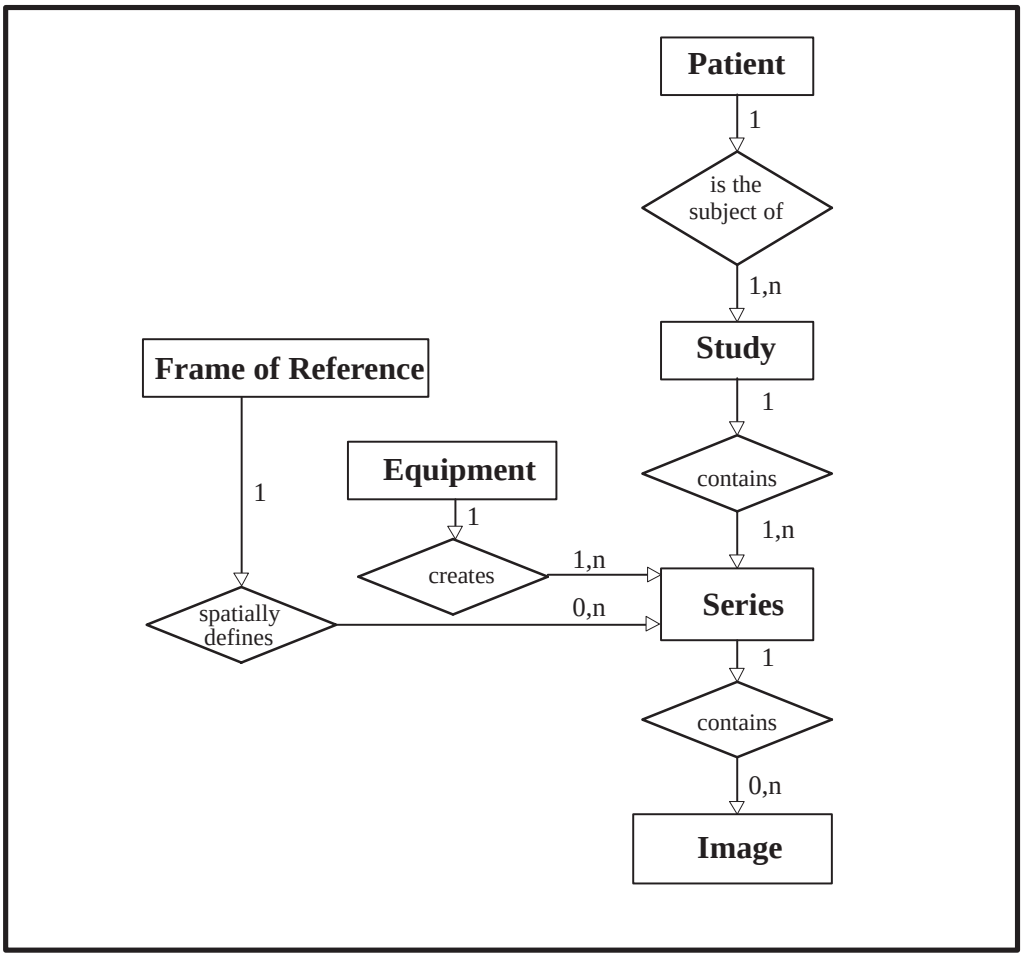
This section specifies the use of the DICOM RT Image IOD to represent the information included in images produced by this implementation. Corresponding attributes are conveyed using the module construct.

4–1 RT Image IOD Implementation

This section defines the implementation of the RT Image information object in the Advantage Sim application. It refers to the DICOM Standard 1998, Part 3 (Information Object Definitions). The Advantage Sim application does not display RT Images directly, but relies on the Advantage Workstation product for this function.

4–2 RT Image IOD Entity–Relationship Model

ILLUSTRATION **4–1**
RT IMAGE ENTITY RELATIONSHIP DIAGRAM



The Entity–Relationship diagram for the RT Image interoperability schema is shown in Illustration 4–1. 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.

4–2–1 Entities Description

Refer to DICOM Standard 1998 Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Image information object.

4–2–2 Advantage Sim Mapping of DICOM entities

DICOM entities map to the Advantage Sim entities in the following manner :

DICOM	Advantage Sim
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 Advantage Sim application is running
Image Entity	Screen Save of *DRR (digitally–reconstructed radiograph) image only* (generated from within application using Advantage Sim menu option in main panel). Advantage Sim does not directly display RT Images.

4–3 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 4–1 identifies the defined modules within the entities which comprise the DICOM RT Image Information Object Definition. Modules are identified by Module Name.

See DICOM Standard 1998 Part 3 for a complete definition of the entities, modules, and attributes.

TABLE 4–1
RT IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	4–4–1–1
Study	General Study	M	4–4–2–1
	Patient Study	U	not used
Series	RT Series	M	4–4–3–1
Frame of Reference	Frame of Reference	U	not used
Equipment	General Equipment	M	4–4–4–1
Image	General Image	M	4–4–5–1
	Image Pixel	M	4–4–5–2
	Contrast/bolus	C	not used
	Cine	C	not used
	Multi–Frame	C	not used
	RT Image	M	4–4–5–3
	Modality LUT	U	not used
	VOI LUT	U	not used
	Approval	U	not used
	Curve	U	not used
	Audio	U	not used
	SOP Common	M	4–4–5–4

4–4 Information Module Definitions

Please refer to DICOM Standard 1998 Part 3 (Information Object Definitions) for a description of each of the entities and modules contained within the RT Image Information Object.

4–4–1 Patient Entity Modules

4–4–1–1 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
Patient's Birth Date	(0010,0030)	2	Duplicated from patient model images if present in those images, otherwise zero–length
Patient's Sex	(0010,0040)	2	Duplicated from patient model images if present in those images, otherwise zero–length

4–4–2 Study Entity Modules

4–4–2–1 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 if present in those images, otherwise zero–length
Accession number	(0008,0050)	2	Duplicated from patient model images if present in those images, otherwise zero–length

4–4–3 Series Entity Modules

4–4–3–1 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	
Series Description	(0008,103E)	3	'Adv Sim RT Images'

4–4–4 Equipment Entity Modules

4–4–4–1 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	'4.0.x' (single–valued)

4–4–5 Image Entity Modules

4–4–5–1 General Image

Attribute Name	Element Tag	TP	Notes
Image Number	(0020,0013)	2	
Patient Orientation	(0020,0020)	2C	Zero–length
Image Date	(0008,0023)	2C	
Image Time	(0008,0033)	2C	
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

4–4–5–2 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 Advantage Sim 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

4–4–5–3 RT Image

Attribute Name	Element Tag	TP	Notes
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
Operators' Name	(0008,1070)	2	Zero–length
Image Type	(0008,0008)	1	'DERIVED\SECONDARY\DRR'
Conversion Type	(0008,0064)	2	'WSD'
Reported Values Origin	(3002,000A)	2C	'PLAN'
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 Advantage Sim
Primary Dosimeter Unit	(300A,00B3)	2	Zero–length
Radiation Machine SAD	(3002,0022)	2	Source–axis distance of machine associated with beam in Advantage Sim
RT Image SID	(3002,0026)	2	Equal to SAD of machine associated with beam in Advantage Sim (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 Advantage Sim. If last saved RT Plan has been subsequently modified in Advantage Sim 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	
>Beam Limiting Device Sequence	(300A,00B6)	3	Sequence will always contain exactly two 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 Advantage Sim
>>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 Advantage Sim

Attribute Name	Element Tag	TP	Notes
>>Leaf Position Boundaries	(300A,00BE)	2C	Provided only for ‘MLCX’ and ‘MLCY’ collimators
>>Leaf/Jaw Positions	(300A,011C)	1C	
>Number of Blocks	(300A,00F0)	1C	Number of blocks or cutouts defined for beam in Advantage Sim
>Block Sequence	(300A,00F4)	2C	
>> Source to Block Tray Distance	(300A,00F6)	2C	Source to Block Tray Distance obtained from machine associated with beam in Advantage Sim
>>Block Type	(300A,00F8)	1C	‘SHIELDING’ or ‘APERTURE’
>>Block Divergence	(300A,00FA)	2C	Zero–length
>>Block Number	(300A,00FC)	1C	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 Advantage Sim
>>Material ID	(300A,00E1)	2	Zero–length
>>Block Number of Points	(300A,0104)	2C	In Advantage Sim there is no software limit imposed on the number of points in a block shape
>>Block Data	(300A,0106)	2C	
Gantry Angle	(300A,011E)	3	
Beam Limiting Device Angle	(300A,0120)	3	
Patient Support Angle	(300A,0122)	3	

4–4–5–4 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 ‘1.2.840.113619.2.68’
Specific Character Set	(0008,0005)	1C	‘ISO_IR 100’
Instance Creation Date	(0008,0012)	3	
Instance Creation Time	(0008,0013)	3	
Instance Creator UID	(0008,0014)	3	‘1.2.840.113619.6.68’

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SECTION 5 – RT STRUCTURE SET INFORMATION OBJECT IMPLEMENTATION

5–0 Introduction

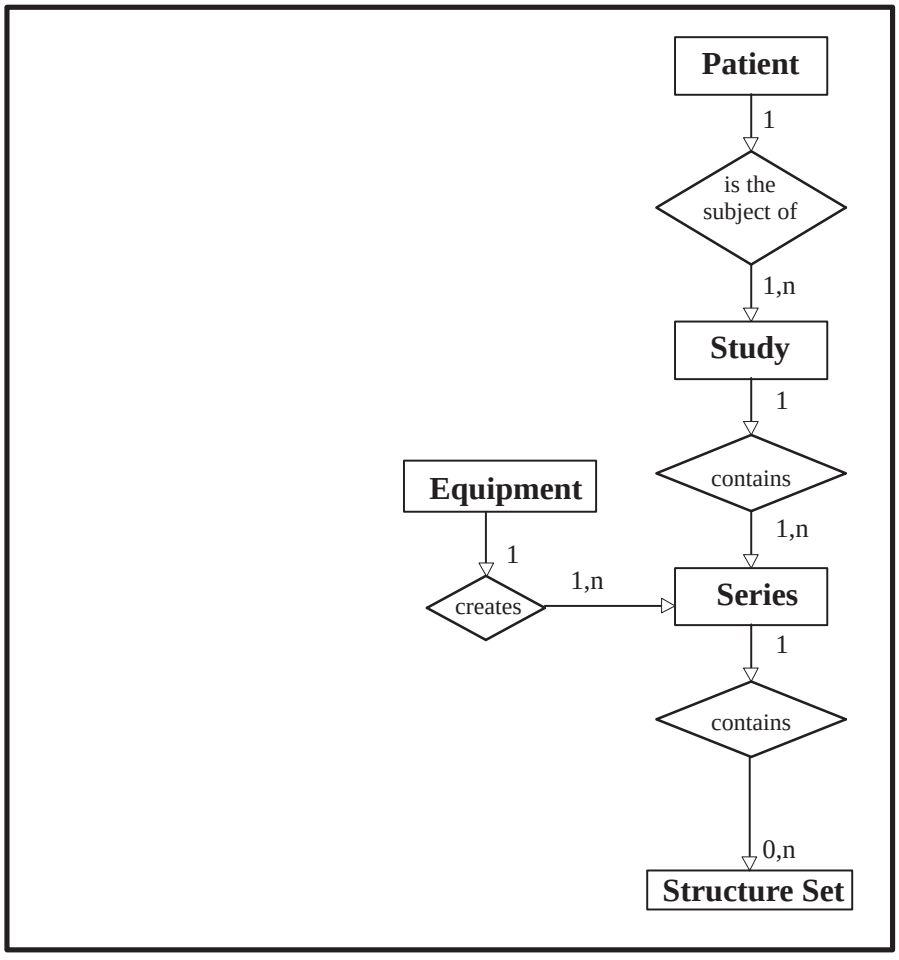
This section specifies the use of the DICOM RT Structure Set IOD to represent the information included in structure sets produced by this implementation. Corresponding attributes are conveyed using the module construct.

5–1 RT Structure Set IOD Implementation

This section defines the implementation of the RT Structure Set information object in the Advantage Sim application. It refers to the DICOM Standard 1998 Part 3 (Information Object Definitions).

5–2 RT Structure Set IOD Entity–Relationship Model

ILLUSTRATION **5–1**
RT STRUCTURE SET ENTITY RELATIONSHIP DIAGRAM



The Entity–Relationship diagram for the RT Structure Set interoperability schema is shown in Illustration 5–1. 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.

5–2–1 Entities Description

Refer to DICOM Standard 1998 Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Structure Set information object.

5–2–2 Advantage Sim Mapping of DICOM entities

DICOM entities map to the Advantage Sim entities in the following manner :

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

5–3 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 5–1 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 1998 Part 3 for a complete definition of the entities, modules, and attributes.

TABLE 5–1
RT STRUCTURE SET INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	5–4–1–1
Study	General Study	M	5–4–2–1
	Patient Study	U	not used
Series	RT Series	M	5–4–3–1
Equipment	General Equipment	M	5–4–4–1
Structure Set	Structure Set	M	5–4–5–1
	ROI Contour	M	5–4–5–2
	RT ROI Observations	M	5–4–5–3
	Approval	U	not used
	Audio	U	not used
	SOP Common	M	5–4–5–4

5–4 Information Module Definitions

Please refer to DICOM Standard 1998 Part 3 (Information Object Definitions) for a description of each of the entities and modules contained within the RT Structure Set Information Object.

5–4–1 Patient Entity Modules

5–4–1–1 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
Patient's Birth Date	(0010,0030)	2	Duplicated from patient model images if present in those images, otherwise zero–length
Patient's Sex	(0010,0040)	2	Duplicated from patient model images if present in those images, otherwise zero–length

5–4–2 Study Entity Modules

5–4–2–1 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 if present in those images, otherwise zero–length
Accession number	(0008,0050)	2	Duplicated from patient model images if present in those images, otherwise zero–length

5–4–3 Series Entity Modules

5–4–3–1 RT Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	'RTSTRUCT'
Series Instance UID	(0020,000E)	1	Created for first image in series, otherwise copied from existing images in series
Series Number	(0020,0011)	2	
Series Description	(0008,103E)	3	'Adv Sim RT Structure Sets'

5–4–4 Equipment Entity Modules

5–4–4–1 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	'4.0.x' (single–valued)

5–4–5 Structure Set Entity Modules

5–4–5–1 Structure Set

Attribute Name	Element Tag	TP	Notes
Structure Set Label	(3006,0002)	1	Equal to comment entered when saving Advantage Sim Plan, truncated to 16 characters
Structure Set Name	(3006,0004)	3	Equal to comment entered when saving Advantage Sim Plan (non–truncated)
Structure Set Date	(3006,0008)	2	
Structure Set Time	(3006,0009)	2	
Referenced Frame of Reference Sequence	(3006,0010)	3	Sequence will always contain exactly one item, corresponding to the frame of reference of the CT images
>Frame of Reference UID	(0020,0052)	1C	Duplicated from patient model images if present in those images, otherwise a unique UID will be created by Advantage Sim
>RT Referenced Study Sequence	(3006,0012)	3	Sequence will always contain exactly one item, corresponding to the Study containing the CT images
>>Referenced SOP Class UID	(0008,1150)	1C	
>>Referenced SOP Instance UID	(0008,1155)	1C	
>>RT Referenced Series Sequence	(3006,0014)	1C	Sequence will always contain exactly one item, corresponding to the Series containing the CT images
>>>Series Instance UID	(0020,000E)	1C	
>>>Contour Image Sequence	(3006,0016)	1C	Sequence will contain all images used in building the Advantage Sim patient model, even if some images have no corresponding contour
>>>>Referenced SOP Class UID	(0008,1150)	1C	
>>>>Referenced SOP Instance UID	(0008,1155)	1C	
Structure Set ROI Sequence	(3006,0020)	3	Always provided unless there have been no structures defined in Advantage Sim, in which case the sequence will be absent

Attribute Name	Element Tag	TP	Notes
>ROI Number	(3006,0022)	1C	Advantage Sim will number structures in increasing numeric order, starting from 1, as they are found in the plan
>Referenced Frame of Reference UID	(3006,0024)	1C	Equal to Frame of Reference UID (0020,0052) above
>ROI Name	(3006,0026)	2C	Equal to Advantage Sim structure name
>ROI Generation Algorithm	(3006,0036)	2C	Zero–length

5–4–5–2 ROI Contour

Attribute Name	Element Tag	TP	Notes
ROI Contour Sequence	(3006,0039)	1	Sequence will always contain all the structures defined in the Structure Set Module, in the same sequential order
>Referenced ROI Number	(3006,0084)	1	
>ROI Display Color	(3006,002A)	3	Contains RGB values corresponding to color used for displaying contour in Advantage Sim application
>Contour Sequence	(3006,0040)	3	Provided if ROI has contours which have been defined by Advantage Sim, otherwise sequence will not be transmitted
>>Contour Image Sequence	(3006,0016)	3	Sequence will always contain exactly one item (referenced CT image)
>>>Referenced SOP Class UID	(0008,1150)	1C	
>>>Referenced SOP Instance UID	(0008,1155)	1C	
>>Contour Geometric Type	(3006,0042)	1C	‘CLOSED_PLANAR’ for structures, ‘POINT’ for markers
>>Contour Slab Thickness	(3006,0044)	3	For structures, equal to the sum of the zplus and zminus half thicknesses in Advantage Sim. Not provided for markers.
>>Number of Contour Points	(3006,0046)	1C	In Advantage Sim there is no limit imposed on the number of points in a contour shape
>>Contour Data	(3006,0050)	1C	Z coordinate of contour data may differ slightly from Z coordinate of referenced slice. This variation should be of the order of half the (x,y) resolution of the reconstructed patient model. Coordinates are in DICOM coordinate system, *not* Voxtool RAS coordinate system. Marker positions in Advantage Sim are not restricted to lie on acquisition slices, and therefore their Z coordinate may take any value.

5–4–5–3 RT ROI Observations

Attribute Name	Element Tag	TP	Notes
RT ROI Observations Sequence	(3006,0080)	1	Sequence will always contain all the structures defined in the Structure Set Module, in the same sequential order
>Observation Number	(3006,0082)	1	Advantage Sim will number observations in increasing numeric order, starting from 1 (i.e. Observation Number will correspond to ROI Number)
>Referenced ROI Number	(3006,0084)	1	
>ROI Observation Label	(3006,0085)	3	Equal to Advantage Sim structure name, truncated to 16 characters
>RT ROI Interpreted Type	(3006,00A4)	2	Supported types are EXTERNAL, PTV, CTV, GTV, AVOIDANCE, ORGAN, CONTRAST_AGENT, CAVITY, and MARKER. Will be zero–length if Structure Type is UNKNOWN in Advantage Sim.
>ROI Interpreter	(3006, 00A6)	2	Zero–length

5–4–5–4 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	‘1.2.840.10008.5.1.4.1.1.481.3’
SOP Instance UID	(0008,0018)	1	UID root will be ‘1.2.840.113619.2.68’
Specific Character Set	(0008,0005)	1C	‘ISO_IR 100’
Instance Creation Date	(0008,0012)	3	
Instance Creation Time	(0008,0013)	3	
Instance Creator UID	(0008,0014)	3	‘1.2.840.113619.6.68’

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SECTION 6 – RT PLAN INFORMATION OBJECT IMPLEMENTATION

6–0 Introduction

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

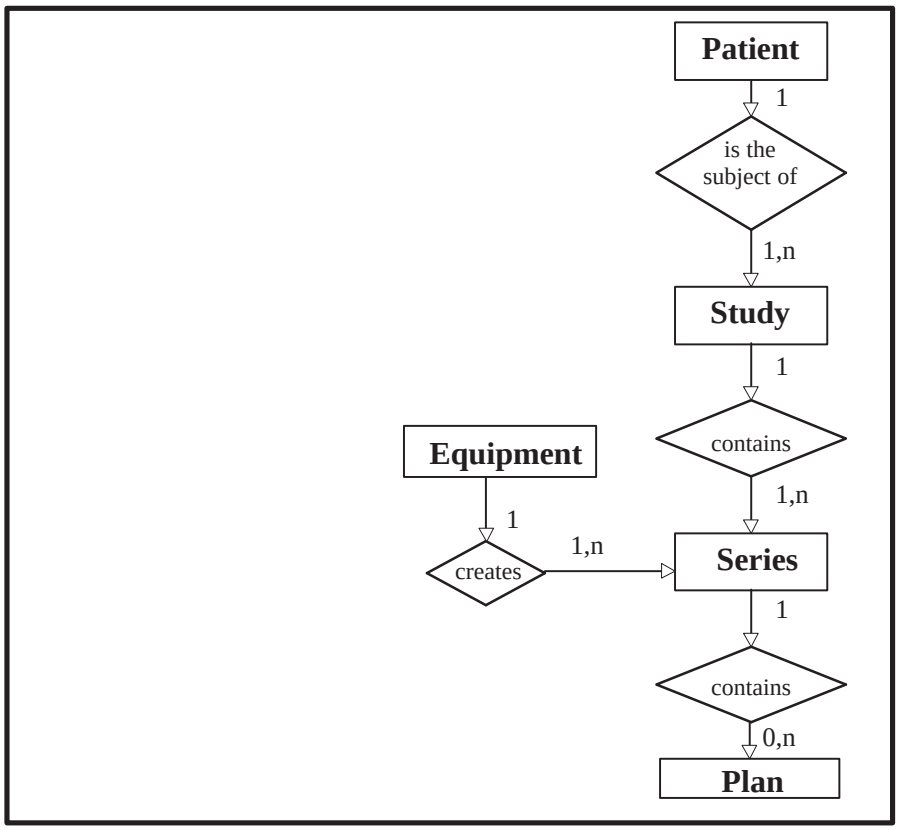
Advantage Sim implements the RT Plan IOD as a Standard Extended object, containing two additional elements in the Beam Sequence (300A,00B0) contained within the RT Beams module (see Section 6–4–5–3 of this document). These two attributes are the Referenced SOP Class UID (0008,1150) and Referenced SOP Instance UID (0008,1155) of the GE Private DICOM Treatment Machine object used for the beam. These attributes have no meaning outside the Advantage Sim application, and are provided to resolve future issues of backward compatibility within the Advantage Sim product line. These attributes should be ignored by SCP implementations interpreting these objects.

6–1 RT Plan IOD Implementation

This section defines the implementation of the RT Plan information object in the Advantage Sim application. It refers to the DICOM Standard 1998 Part 3 (Information Object Definitions).

6–2 RT Plan IOD Entity–Relationship Model

ILLUSTRATION **6–1**
RT PLAN ENTITY RELATIONSHIP DIAGRAM



The Entity–Relationship diagram for the RT Plan interoperability schema is shown in Illustration 6–1. In this figure, the following diagrammatic convention is established to represent the information organization :

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

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

6–2–1 Entities Description

Refer to DICOM Standard 1998 Part 3 (Information Object Definitions) for a description of each of the entities contained within the RT Plan information object.

6–2–2 Advantage Sim Mapping of DICOM entities

DICOM entities map to the Advantage Sim entities in the following manner :

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

6–3 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 6–1 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 1998 Part 3 for a complete definition of the entities, modules, and attributes.

TABLE 6–1
RT PLAN INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	6–4–1–1
Study	General Study	M	6–4–2–1
	Patient Study	U	not used
Series	RT Series	M	6–4–3–1
Equipment	General Equipment	M	6–4–4–1
Plan	RT General Plan	M	6–4–5–1
	RT Prescription	U	not used
	RT Tolerance Tables	U	not used
	RT Patient Setup	U	6–4–5–2
	RT Fraction Scheme	U	not used
	RT Beams	C	6–4–5–3
	RT Brachy Application Setups	C	not used
	Approval	U	not used
	Audio	U	not used
	SOP Common	M	6–4–5–4

6–4 Information Module Definitions

Please refer to DICOM Standard 1998 Part 3 (Information Object Definitions) for a description of each of the entities and modules contained within the RT Plan Information Object.

6–4–1 Patient Entity Modules

6–4–1–1 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
Patient's Birth Date	(0010,0030)	2	Duplicated from patient model images if present in those images, otherwise zero–length
Patient's Sex	(0010,0040)	2	Duplicated from patient model images if present in those images, otherwise zero–length

6–4–2 Study Entity Modules

6–4–2–1 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 if present in those images, otherwise zero–length
Accession number	(0008,0050)	2	Duplicated from patient model images if present in those images, otherwise zero–length

6–4–3 Series Entity Modules

6–4–3–1 RT Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	'RTPLAN'
Series Instance UID	(0020,000E)	1	Created for first image in series, otherwise copied from existing images in series
Series Number	(0020,0011)	2	
Series Description	(0008,103E)	3	'Adv Sim RT Plans'

6–4–4 Equipment Entity Modules

6–4–4–1 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	'4.0.x' (single–valued)

6–4–5 Plan Entity Modules

6–4–5–1 RT General Plan

Attribute Name	Element Tag	TP	Notes
RT Plan Label	(300A,0002)	1	Equal to comment entered when saving Advantage Sim Plan, truncated to 16 characters
RT Plan Name	(300A,0003)	3	Equal to comment entered when saving Advantage Sim Plan (non–truncated)
Operators' Name	(0008,1070)	2	Equal to operator name entered when saving Advantage Sim Plan
RT Plan Date	(300A,0006)	2	
RT Plan Time	(300A,0007)	2	
RT Plan Geometry	(300A,000C)	1	'PATIENT'
Reference Structure Set Sequence	(300C,0060)	1C	Sequence will always contain exactly one item, referencing RT Structure Set saved at same time as Plan
>Referenced SOP Class UID	(0008,1150)	1C	'1.2.840.10008.5.1.4.1.1.481.3' (RT Structure Set)
>Referenced SOP Instance UID	(0008,1155)	1C	

6–4–5–2 RT Patient Setup

Attribute Name	Element Tag	TP	Notes
Patient Setup Sequence	(300A,0180)	1	Sequence will always contain exactly one item
>Patient Setup Number	(300A,0182)	1	1
>Patient Position	(0018,5100)	1C	Patient treatment position in Advantage Sim 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.

6–4–5–3 RT Beams

Attribute Name	Element Tag	TP	Notes
Beam Sequence	(300A,00B0)	1	Always provided unless no beams have been defined in Advantage Sim, in which case the entire module will be absent
>Beam Number	(300A,00C0)	1	Advantage Sim will number beams in increasing numeric order, starting from 1, as they are found in the Plan
>Beam Name	(300A,00C2)	3	Equal to Advantage Sim beam name
>Beam Type	(300A,00C4)	1	'STATIC'
>Radiation Type	(300A,00C6)	2	Zero–length if not defined for current beam, otherwise 'PHOTON' or 'ELECTRON'
>Treatment Machine Name	(300A,00B2)	2	Name (including suffix) of machine associated with beam in Advantage Sim. If treatment machine has not been defined in Advantage Sim for one or more beams, it will not be possible to save the plan.
>Referenced SOP Class UID	(0008,1150)	3	Private (GE) SOP Class of machine used to define current beam. Equal to '1.2.840.113619.4.5.251'. GE Standard Extended attribute.
>Referenced SOP Instance UID	(0008,1155)	3	Private (GE) SOP Instance of machine used to define current beam. GE Standard Extended attribute.
>Source–Axis Distance	(300A,00B4)	3	Source–axis distance of machine associated with beam in Advantage Sim
>Beam Limiting Device Sequence	(300A,00B6)	1	Sequence will always contain exactly two items
>>RT Beam Limiting Device Type	(300A,00B8)	1	Will be 'X', 'Y', 'ASYMX', 'ASYMY', 'MLCX' or 'MLCY', according to collimator type of machine associated with beam in Advantage Sim
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	
>>Leaf Position Boundaries	(300A,00BE)	2C	Provided only for 'MLCX' and 'MLCY' collimators
>Referenced Patient Setup Number	(300C,006A)	3	1 (i.e. references only patient setup specified in RT Patient Setup module)
>Treatment Delivery Type	(300A,00CE)	3	'TREATMENT'
>Number of Wedges	(300A,00D0)	1	0
>Number of Compensators	(300A,00E0)	1	0
>Number of Boli	(300A,00ED)	1	0
>Number of Blocks	(300A,00F0)	1	Equal to number of Blocks or Cutouts defined for beam in Advantage sim
>Block Sequence	(300A,00F4)	1C	Provided if Number of Blocks greater than 0
>>Source to Block Tray Distance	(300A,00F6)	2C	Equal to Source to Block Tray Distance obtained from machine definition of machine associated with beam in Advantage Sim
>>Block Type	(300A,00F8)	1C	'SHIELDING' or 'APERTURE'
>>Block Divergence	(300A,00FA)	2C	Zero–length

Attribute Name	Element Tag	TP	Notes
>>Block Number	(300A,00FC)	1C	Blocks will be numbered from 1 to n in order presented in sequence
>>Block Name	(300A,00FE)	3	Equal to block name entered in Advantage Sim
>>Material ID	(300A,00E1)	2C	Zero–length
>>Block Thickness	(300A,0100)	2C	Zero–length
>>Block Transmission	(300A,0102)	2C	Zero–length.
>>Block Number of Points	(300A,0104)	2C	In Advantage Sim there is no software limit imposed on the number of points in a block shape
>>Block Data	(300A,0106)	2C	
>Final Cumulative Meterset Weight	(300A,010E)	2C	100
>Number of Control Points	(300A,0110)	1	2 (static beam)
>Control Point Sequence	(300A,0111)	1	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), with a value of 100.
>>Control Point Index	(300A,0112)	1C	0 for first control point, 1 for second control point
>>Cumulative Meterset Weight	(300A,0134)	2C	0 for first control point, 100 for second control point
>>Nominal Beam Energy	(300A,0114)	3	Provided for first control point only if beam energy defined in Advantage Sim, otherwise attribute not provided
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	Provided for first control point only. Sequence will contain exactly two items.
>>>RT Beam Limiting Device Type	(300A,00B8)	1C	Provided for first control point only
>>>Leaf/Jaw Positions	(300A,011C)	1C	Provided for first control point only
>>Gantry Angle	(300A,011E)	1C	Provided for first control point only
>>Gantry Rotation Direction	(300A,011F)	1C	Provided (value ‘NONE’) for first control point only
>>Beam Limiting Device Angle	(300A,0120)	1C	Provided for first control point only
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	Provided (value ‘NONE’) for first control point only
>>Patient Support Angle	(300A,0122)	1C	Provided for first control point only
>>Patient Support Rotation Direction	(300A,0123)	1C	Provided (value ‘NONE’) for first control point only
>>Table Top Eccentric Angle	(300A,0125)	1C	Provided (value 0) for first control point only (no eccentric rotation possible in Advantage Sim)
>>Table Top Eccentric Rotation Direction	(300A,0126)	1C	Provided (value ‘NONE’) for first control point only
>>Table Top Vertical Position	(300A,0128)	2C	Provided (zero–length) for first control point only
>>Table Top Longitudinal Position	(300A,0129)	2C	Provided (zero–length) for first control point only

Attribute Name	Element Tag	TP	Notes
>>Table Top Lateral Position	(300A,012A)	2C	Provided (zero–length) for first control point only
>>Isocenter Position	(300A,012C)	2C	Provided for first control point only

6–4–5–4 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	‘1.2.840.10008.5.1.4.1.1.481.5’
SOP Instance UID	(0008,0018)	1	UID root will be ‘1.2.840.113619.2.68’
Specific Character Set	(0008,0005)	1C	‘ISO_IR 100’
Instance Creation Date	(0008,0012)	3	
Instance Creation Time	(0008,0013)	3	
Instance Creator UID	(0008,0014)	3	‘1.2.840.113619.6.68’

SECTION 7 – GE PRIVATE DICOM RT PLAN INFORMATION OBJECT IMPLEMENTATION

7–0 Introduction

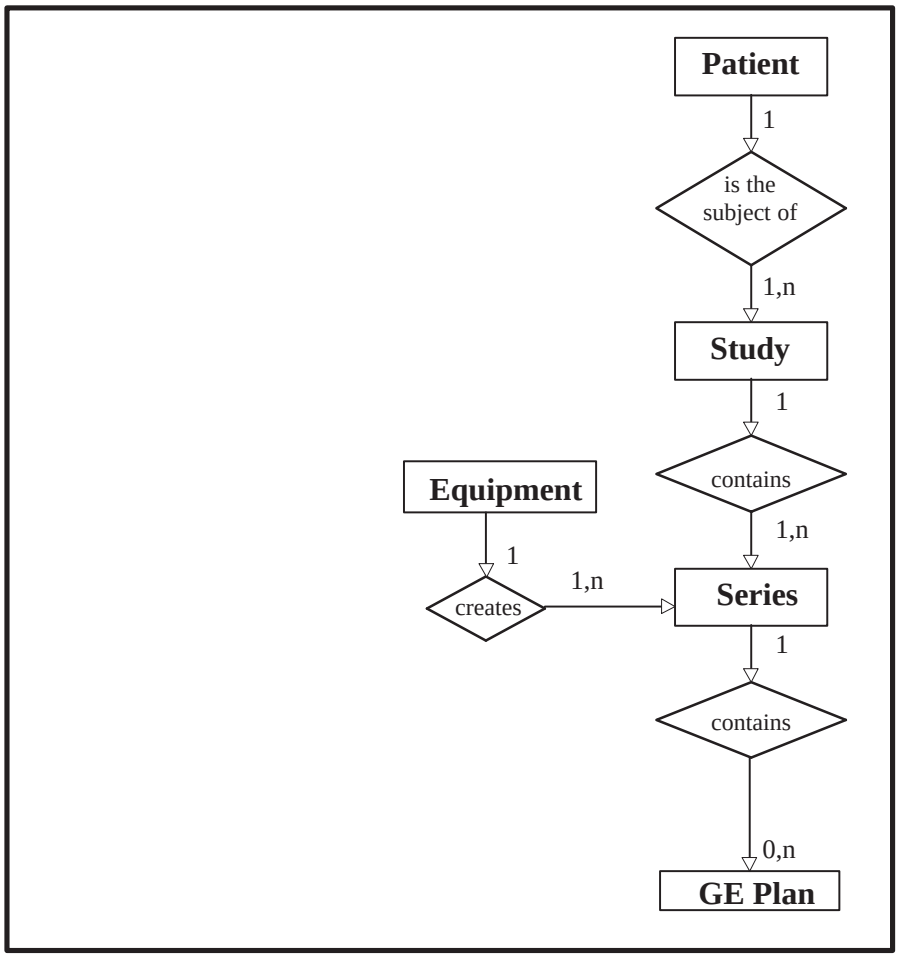
This section specifies the use of the GE Private DICOM RT Plan IOD to represent the information included in plans produced by this implementation. Corresponding attributes are conveyed using the module construct.

7–1 GE Private DICOM RT Plan IOD Implementation

This section defines the implementation of the GE Private DICOM RT Plan information object in the Advantage Sim application.

7–2 GE Private DICOM RT Plan IOD Entity–Relationship Model

ILLUSTRATION **7–1**
GE PRIVATE DICOM RT PLAN ENTITY RELATIONSHIP DIAGRAM



The Entity–Relationship diagram for the GE Private DICOM RT Plan interoperability schema is shown in Illustration 7–1. 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.

7–2–1 Entities Description

Each of the entities contained within the GE Private DICOM RT Plan information object is fully described in Section 7–4.

7–2–2 Advantage Sim Mapping of DICOM entities

DICOM entities map to the Advantage Sim entities in the following manner :

DICOM	Advantage Sim
Patient Entity	Patient Entity (Advantage Workstation)
Study Entity	Examination Entity (Advantage Workstation)
Series Entity	No mapping
GE Plan Entity	Advantage Sim information relating to defined structures, markers, and beams

7–3 GE Private DICOM RT Plan IOD Module Table

Within an entity of the GE Private 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 7–1 identifies the defined modules within the entities which comprise the GE Private DICOM RT Plan Information Object Definition. Modules are identified by Module Name.

TABLE 7–1
GE PRIVATE DICOM RT PLAN INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	7–4–1–1
Study	General Study	M	7–4–2–1
Equipment	General Equipment	U	7–4–3–1
GE Plan	RT Plan General Information	M	7–4–4–1
	RT Structure Sequence	U	7–4–4–2
	RT Marker Sequence	U	7–4–4–3
	RT Beam Sequence	U	7–4–4–4
	SOP Common	M	7–4–4–5

7–4 Information Module Definitions

7–4–1 Patient Entity Modules

7–4–1–1 Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	1	Duplicated from patient model images
Patient ID	(0010,0020)	2	Duplicated from patient model images if present in those images, otherwise zero–length
Patient's Birth Date	(0010,0030)	2	Duplicated from patient model images if present in those images, otherwise zero–length
Patient's Sex	(0010,0040)	2	Duplicated from patient model images if present in those images, otherwise zero–length

7–4–2 Study Entity Modules

7–4–2–1 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 if present in those images, otherwise zero–length. Note: this attribute was not provided by Advantage Sim 1.2.
Accession number	(0008,0050)	2	Zero–length

7–4–3 Equipment Entity Modules

7–4–3–1 General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	'GE MEDICAL SYSTEMS'
Manufacturer's Model Name	(0008,1090)	3	'Advantage Sim'
Device Serial Number	(0018,1000)	3	<station host ID>
Software Versions	(0018,1020)	3	'4.0.x' (single–valued)

7–4–4 Radiotherapy Plan Entity Modules

7–4–4–1 RT Plan General Information

WARNING

THE RT PLAN GENERAL INFORMATION MODULE CONTAINS THE MANDATORY ATTRIBUTE TREATMENT POSITION (0249,D0) WHICH WAS NOT PRESENT IN THE GE PRIVATE DICOM RT PLAN INFORMATION OBJECT CREATED BY ADVANTAGE SIM 1.2. RECEIVING IMPLEMENTATIONS MUST READ AND INTERPRET THIS ATTRIBUTE TO CORRECTLY TREAT THE PATIENT.

Attribute Name	Element Tag	TP	Notes
Plan Creation Date	(0249,11)	1	Date the plan was created
Plan Creation Time	(0249,13)	1	Time the plan was created
Operator Name	(0249,14)	2	Name of operator which defined the RT Plan. Always non–zero length for Advantage Sim.
Plan Comment	(0249,16)	2	User–defined comments on the RT Plan. Always non–zero length for Advantage Sim.
Plan Image Sequence	(0249,18)	3	Introduces sequence of items describing images used in defining the RT Plan. All referenced images shall belong to the same series. Always provided by Advantage Sim.
>Exam/Series/Image Identifier	(0249,1A)	3	Exam/Series/Image identifier (e.g. ‘e6270/s2/i4’), as provided by image source (e.g. CT scanner). Always provided by Advantage Sim.
>Additional Image Identifier	(0249,1B)	3	Additional identifier aiding in uniquely identifying image. Always provided by Advantage Sim.
Build Resolution	(0249,1C)	3	Resolution used to build 3D model. Defined terms: LOW, HIGH. Always provided by Advantage Sim.
Modality	(0008,0060)	1	Type of equipment that originally acquired the data used to create the objects in this series. Always equal to ‘RT’ for Advantage Sim.
Series Instance UID	(0020,000E)	1	A number that identifies this series. For Advantage Sim, the Series UID shall be equal to the Study Instance UID concatenated with the string ‘.249’. If the resulting string exceeds 64 characters, as many characters as necessary shall be removed from the front of the string.
Series Number	(0020,0011)	1	A number that identifies this series. For AdvantageSim this value shall be ‘350’.
Series Description	(0008,103E)	2	User–provided description of the series. Always equal to ‘Radiotherapy’ for Advantage Sim.

Attribute Name	Element Tag	TP	Notes
Image Number	(0020,0013)	1	The plan number. This value will be created by Advantage Sim during storage, but is not guaranteed to be unique.
Treatment Position	(0249,D0)	1	Patient position during treatment, as described in DICOM Part 3 Section C.7.3.1.1.2. May be different from scanned orientation when patient has been scanned FFS or FFP, and 'flip' patient option is selected in Advantage Sim (in which case treatment orientations will be HFS and HFP respectively). **Note: This attribute was not supplied in Advantage Sim 1.2 because treatment orientation was always the same as scanned orientation.**

7–4–4–2 RT Structure Sequence

Attribute Name	Element Tag	TP	Notes
Structure Sequence	(0249,20)	1	Introduces sequence of items describing structures defined for plan. Sequence shall not be empty.
>Structure Name	(0249,22)	1	Name of structure
>Structure Type	(0249,24)	1	Type of structure. Defined terms: BODY, ORGAN, TUMOR, TARGET, UNKNOWN. The Structure Type for the external body contour (if it exists) shall always be BODY. Mappings from Structure Type (0249,24) to RT ROI Interpreted Type (3006,00A4) in the RT Plan object are as follows: BODY = EXTERNAL TARGET = PTV CTV = CTV TUMOR = GTV AVOIDANCE = AVOIDANCE ORGAN = ORGAN CONTRAST_AGENT = CONTRAST_AGENT CAVITY = CAVITY UNKNOWN = zero–length
>Structure Color	(0249,28)	3	Representation color of structure. Defined terms: RED, BLUE, GREEN, YELLOW, PINK, VIOLET. Always provided by Advantage Sim.
>Slab Sequence	(0249,30)	3	Introduces sequence of items describing slabs defined for structure. If present, sequence shall not be empty.
>>Slab Image Sequence	(0249,32)	3	Introduces sequence describing image used in defining the slab. Sequence shall always contain exactly one item.
>>>Exam/Series/Image Identifier	(0249,1A)	3	Exam/Series/Image identifier (e.g. 'e6270/s2/i4'), as provided by image source (e.g. CT scanner). Always provided by Advantage Sim.
>>Z Plus Thickness	(0249,36)	1C	Thickness of slab (mm) in +z direction (see 7–4–4–2–1 and 7–4–4–2–2). Required if Slab Sequence is present.

>>Z Minus Thickness	(0249,38)	1C	Thickness of slab (mm) in –z direction (see 7–4–4–2–1 and 7–4–4–2–2). Required if Slab Sequence is present.
>>Slab Shape	(0249,3A)	1C	Sequence of 3D points defining slab shape (see 7–4–4–2–1 and 7–4–4–2–3). Required if Slab Sequence is present. Z coordinate of contour data may differ slightly from Z coordinate of referenced slice. This variation should be of the order of half the (x,y) resolution of the reconstructed patient model.

7–4–4–2–1 DICOM Coordinate System

Structures will be represented using the DICOM (LPS) coordinate system as defined in DICOM Part 3 Section C.7.6.2.1. Note that this is not the same as the RAS coordinate system used in the *Advantage Sim* user interface.

7–4–4–2–2 Slab Thickness

For acquisition slices with gantry tilt, Z Plus Thickness and Z Minus Thickness shall be equal to the *perpendicular* thickness of the slice, not the thickness projected onto the z–axis.

7–4–4–2–3 Slab Shape

The ‘Slab Shape’ attribute defines a list of 3D points lying in a plane. These points are assumed to form a closed contour, and will be listed as x_1, y_1, z_1, x_2, y_2, z_2, x_3, y_3, z_3,...x_n, y_n, z_n using the DICOM coordinate system. The z coordinates of each point in a contour will normally be the same, except when the contour is defined on a CT slice acquired with gantry ‘tilt’.

In general structures may be bifurcated, and may be ‘annular’ in nature (i.e. have a contour completely enclosed within another). It is up to the receiving application to detect these situations and take action as necessary.

7–4–4–3 RT Marker Sequence

Attribute Name	Element Tag	TP	Notes
Marker Sequence	(0249,40)	1	Introduces sequence of items describing markers defined for plan. Sequence shall not be empty.
>Marker Name	(0249,42)	1	Name of marker
>Marker Color	(0249,44)	3	Representation color of marker. Always equal to ‘YELLOW’ for Advantage Sim.
>Marker Position	(0249,46)	1	Marker coordinates expressed in DICOM coordinate system. Marker positions in Advantage Sim are not restricted to lie on acquisition slices, and therefore the Z coordinate may take any value. See 7–4–4–2–1.

7–4–4–4 RT Beam Sequence

Attribute Name	Element Tag	TP	Notes
Beam Group Sequence	(0249,50)	1	Introduces sequence of items describing beam groups defined for plan. Sequence shall not be empty. See 7–4–4–4–1.
>Group Name	(0249,51)	1	Group name. Must be unique within plan.

Attribute Name	Element Tag	TP	Notes
>Group Properties	(0249,52)	2	Beam Group properties. Defined terms: EQUAL_ANGLES, COMM_ISOCENTER.
>Beam Sequence	(0249,54)	3	Introduces sequence of items describing beams defined for group. If present, sequence shall not be be empty.
>>Machine Reference Sequence	(0249,60)	1C	Introduces sequence describing machine used in defining the beam. Sequence shall always contain exactly one item. If a machine has not been defined for one or more beams in Advantage Sim, it will not be possible to save the plan. Required if Beam Sequence is present.
>>>Referenced SOP Class UID	(0008,1150)	2C	Uniquely identifies the referenced machine SOP Class. Required if Beam Sequence is present.
>>>Referenced SOP Instance UID	(0008,1155)	2C	Uniquely identifies the referenced machine SOP Instance. Required if Beam Sequence is present,
>>>Machine Name	(0249,62)	2C	Name of referenced machine (including suffix). Required if Beam Sequence is present.
>>Beam Name	(0249,64)	1C	Beam name. Required if Beam Sequence is present. Must be unique within plan.
>>Particle Type	(0249,66)	2	Beam particle type. Defined terms: PHOTON, ELECTRON. Zero–length if beam particle type is not defined.
>>Nominal Particle Energy	(0249,68)	2	Nominal energy of beam in MV/MeV. Zero–length if nominal beam energy is not defined.
>>Block Sequence	(0249,70)	3	Introduces sequence of blocks. Shall be permitted only if if Particle Type is PHOTON. Absent if no blocks are defined for beam.
>>>Block Name	(0249,72)	1C	Block name. Required if Block Sequence is present.
>>>Block Shape	(0249,74)	1C	List of 2D points defining block shape at isocenter. Required if Block Sequence is present. See 7–4–4–4–2.
>>>Block Type	(0249,76)	1C	Type of Block. Enumerated Values: SHIELDING, APERTURE. Required if Block Sequence is present. **Note: This attribute was not supplied in Advantage Sim 1.2 or Advantage Sim 3.0.**
>>Cutout Sequence	(0249,80)	3	Introduces sequence of cutouts. Shall be permitted only if Particle Type is ELECTRON. Absent if no cutouts are defined for beam.
>>>Cutout Name	(0249,82)	1C	Cutout name. Required if Cutout Sequence is present.
>>>Cutout Shape	(0249,84)	1C	List of 2D points defining cutout shape at isocenter. Required if Cutout Sequence is present. See 7–4–4–4–2.
>>>Cutout Type	(0249,86)	1C	Type of Cutout. Enumerated Values: SHIELDING, APERTURE. Required if Cutout Sequence is present. **Note: This attribute was not supplied in Advantage Sim 1.2 or Advantage Sim 3.0.**
>>Collimator Name	(0249,90)	1C	Name of collimator as defined in machine definition. Required if Beam Sequence is present.

Attribute Name	Element Tag	TP	Notes
>>Collimator Type	(0249,92)	1C	Collimator type for beam. Enumerated values: SYMMETRIC, ASYMMETRICX, ASYMMETRICY, BIASYMMETRIC, MULTILEAFX, MULTILEAFY. Required if Beam Sequence is present.
>>Dynamic Segment Sequence	(0249,A0)	1C	Introduces sequence of beam segments for a dynamic beam. For Advantage Sim, sequence shall always contain exactly one item (i.e. static beam). Required if Beam Sequence is present. See 7–4–4–4–3.
>>>Table Angle	(0249,A2)	2C	Table angle in degrees expressed using IEC–1217 convention. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present.
>>>Gantry Angle	(0249,A4)	2C	Gantry angle in degrees expressed using IEC–1217 convention. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present.
>>>Collimator Angle	(0249,A6)	2C	Collimator angle in degrees expressed using IEC–1217 convention. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present.
>>>Isocenter Position	(0249,A8)	2C	Isocenter coordinates expressed in DICOM coordinate system (see 7–4–4–2–1). Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present.
>>>Source–Surface Distance	(0249,A9)	3	Distance between beam source and patient surface (SSD) in mm. See 7–4–4–4–4.
>>>X Symmetric Opening	(0249,AA)	2C	Full–width of IEC–1217 X collimator opening in mm. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present and Collimator Type is SYMMETRIC or ASYMMETRICY. See 7–4–4–4–5.
>>>Y Symmetric Opening	(0249,AC)	2C	Full–width of IEC–1217 Y collimator opening in mm. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present and Collimator Type is SYMMETRIC or ASYMMETRICX. See 7–4–4–4–5.
>>>X Positive Jaw Position	(0249,AE)	2C	Position of positive X asymmetric collimator jaw in mm. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present and Collimator Type is ASYMMETRICX, BIASYMMETRIC, or MULTILEAFY. See 7–4–4–4–5 and 7–4–4–4–6.
>>>X Negative Jaw Position	(0249,B0)	2C	Position of negative X asymmetric collimator jaw in mm. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present and Collimator Type is ASYMMETRICX, BIASYMMETRIC, or MULTILEAFY. See 7–4–4–4–5 and 7–4–4–4–6.

Attribute Name	Element Tag	TP	Notes
>>>Y Positive Jaw Position	(0249,B2)	2C	Position of positive Y asymmetric collimator jaw in mm. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present and Collimator Type is ASYMMETRICY, BIASYMMETRIC, or MULTILEAFX. See 7–4–4–4–5 and 7–4–4–4–6.
>>>Y Negative Jaw Position	(0249,B4)	2C	Position of negative Y asymmetric collimator jaw in mm. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present and Collimator Type is ASYMMETRICY, BIASYMMETRIC, or MULTILEAFX. See 7–4–4–4–5 and 7–4–4–4–6.
>>> Leaf Positions	(0249,B6)	2C	Positions of leaves in mm, in the order L_{1N}, L_{1P}, L_{2N}, L_{2P},...L_{NN}, L_{NP}. where N are the most negative leaves and P are the most positive leaves. Shall be non–zero length for first item in sequence. Required if Dynamic Segment Sequence is present and Collimator Type is MULTILEAFX or MULTILEAFY. See 7–4–4–4–5 and 7–4–4–4–6.

7–4–4–4–1 Machine Conventions

All machine coordinates used to describe treatment beams are specified in the coordinate systems defined by the IEC Standard *IEC 1217: Radiotherapy equipment – Coordinates, movements and scales (1996)*

7–4–4–4–2 Block and Cutout Shapes

The ‘Block Shape’ and ‘Cutout Shape’ attributes each define a list of 2D points lying in the plane through the beam isocenter and perpendicular to the beam axis. These points are assumed to form a closed contour, and will be listed as x_1, y_1, x_2, y_2, x_3, y_3,...x_n, y_n.

The Block Type (0249,76) and Cutout Type (0249,86) attributes define whether the block or cutout contains the attenuating material inside the defined shape (SHIELDING), or outside the defined shape (APERTURE). For APERTURE types, the receiving system may need to complete the block or cutout shape (e.g. create a ”keyhole” block) prior to dosimetry.

7–4–4–4–3 Dynamic Segment Sequence

Each external beam can be represented by a sequence of one or more Dynamic Segment Sequence items. For conventional fixed beams, there will be exactly one item in the sequence, and all required (Type 2) attributes except those not relevant to the specified collimator type will be of non–zero length. For dynamic beams, there will be a sequence of dynamic segments, where unchanged attributes may have zero–length. For example, a standard arced beam will have two items in the sequence: the first will describe all the necessary beam parameters, and the second will have all parameters zero–length except the gantry angle, which will indicate the stop gantry angle. **All beams supplied by Advantage Sim will be static, i.e. will contain exactly one item in the Dynamic Segment Sequence.**

7–4–4–4–4 Source–Surface Distance

For *Advantage Sim*, SSD stored is the distance from the beam origin to the first point encountered in the 3D patient model. This may not correspond to the distance calculated using the ‘BODY’ structure. The presence of a treatment table which has not been removed using the ‘‘Remove Couch’’ option may also modify the stored SSD value.

7–4–4–4–5 Jaw and Leaf Conventions

The negative jaws and leaves are located on the side with the most negative coordinate in the IEC collimator axis perpendicular to the jaw or leaf edge. The positive jaws and leaves are located on the side with the most positive coordinate in the IEC collimator axis perpendicular to the jaw or leaf edge. Leaf pair 1 is located at the most negative position in the IEC collimator axis parallel to the leaf edges. The jaw or leaf position is defined as the coordinate along the corresponding axis using the IEC coordinate conventions (e.g. for a 10 cm symmetric field implemented with a pair of X–asymmetric jaws, X Negative Jaw Position = – 50, X Positive Jaw Position = + 50).

7–4–4–4–6 Collimator Representation

The six types of collimator defined by the 'Collimator Type' attribute each require different combinations of the collimator definition attributes, according to the following rules:

- SYMMETRIC collimators require that 'X Symmetric Opening' and 'Y Symmetric Opening' be defined.
- ASYMMETRICX collimators require that 'Y Symmetric Opening', 'X Positive Jaw Position', and 'X Negative Jaw Position' be defined.
- ASYMMETRICY collimators require that 'X Symmetric Opening', 'Y Positive Jaw Position', and 'Y Negative Jaw Position' be defined.
- BIASYMMETRIC collimators require that 'X Positive Jaw Position', 'X Negative Jaw Position', 'Y Positive Jaw Position', and 'Y Negative Jaw Position' be defined.
- MULTILEAFX collimators require that 'Leaf Positions', 'Y Positive Jaw Position', and 'Y Negative Jaw Position' be defined.
- MULTILEAFY collimators require that 'Leaf Positions', 'X Positive Jaw Position', and 'X Negative Jaw Position' be defined.

7–4–4–5 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	'1.2.840.113619.4.5.249'
SOP Instance UID	(0008,0018)	1	UID root will be '1.2.840.113619.2.68'
Instance Creation Date	(0008,0012)	3	
Instance Creation Time	(0008,0013)	3	

7–5 Private Data Dictionary for GE Private DICOM RT Plan

Private Creator Identification GEMS_RTEN_01

Attribute Name	Element Tag	VR	VM
Plan Creation Date	(0249,11)	DA	1
Plan Creation Time	(0249,13)	TM	1
Operator Name	(0249,14)	PN	1
Plan Comment	(0249,16)	LO	1
Plan Image Sequence	(0249,18)	SQ	1
Exam/Series/Image Identifier	(0249,1A)	LO	1
Additional Image Identifier	(0249,1B)	IS	1
Build Resolution	(0249,1C)	CS	1
Structure Sequence	(0249,20)	SQ	1
Structure Name	(0249,22)	SH	1
Structure Type	(0249,24)	CS	1
Structure Color	(0249,28)	CS	1
Slab Sequence	(0249,30)	SQ	1
Slab Image Sequence	(0249,32)	SQ	1
Z Plus Thickness	(0249,36)	DS	1
Z Minus Thickness	(0249,38)	DS	1
Slab Shape	(0249,3A)	DS	3–n
Marker Sequence	(0249,40)	SQ	1
Marker Name	(0249,42)	SH	1
Marker Color	(0249,44)	CS	1
Marker Position	(0249,46)	DS	3
Beam Group Sequence	(0249,50)	SQ	1
Group Name	(0249,51)	SH	1
Group Properties	(0249,52)	CS	0–n
Beam Sequence	(0249,54)	SQ	1
Machine Reference Sequence	(0249,60)	SQ	1
Machine Name	(0249,62)	SH	1
Beam Name	(0249,64)	SH	1
Particle Type	(0249,66)	CS	1
Nominal Particle Energy	(0249,68)	DS	1
Block Sequence	(0249,70)	SQ	1
Block Name	(0249,72)	LO	1
Block Shape	(0249,74)	DS	2–n
Block Type	(0249,76)	CS	1

Attribute Name	Element Tag	VR	VM
Cutout Sequence	(0249,80)	SQ	1
Cutout Name	(0249,82)	LO	1
Cutout Shape	(0249,84)	DS	2–n
Cutout Type	(0249,86)	CS	1
Collimator Name	(0249,90)	SH	1
Collimator Type	(0249,92)	CS	1
Dynamic Segment Sequence	(0249,A0)	SQ	1
Table Angle	(0249,A2)	DS	1
Gantry Angle	(0249,A4)	DS	1
Collimator Angle	(0249,A6)	DS	1
Isocenter Position	(0249,A8)	DS	3
Source–Surface Distance	(0249,A9)	DS	1
X Symmetric Opening	(0249,AA)	DS	1
Y Symmetric Opening	(0249,AC)	DS	1
X Positive Jaw Position	(0249,AE)	DS	1
X Negative Jaw Position	(0249,B0)	DS	1
Y Positive Jaw Position	(0249,B2)	DS	1
Y Negative Jaw Position	(0249,B4)	DS	1
Leaf Positions	(0249,B6)	DS	2–n
Treatment Position	(0249,D0)	CS	1

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SECTION 8 – CT IMAGE INFORMATION OBJECT REQUIREMENTS

8–0 Introduction

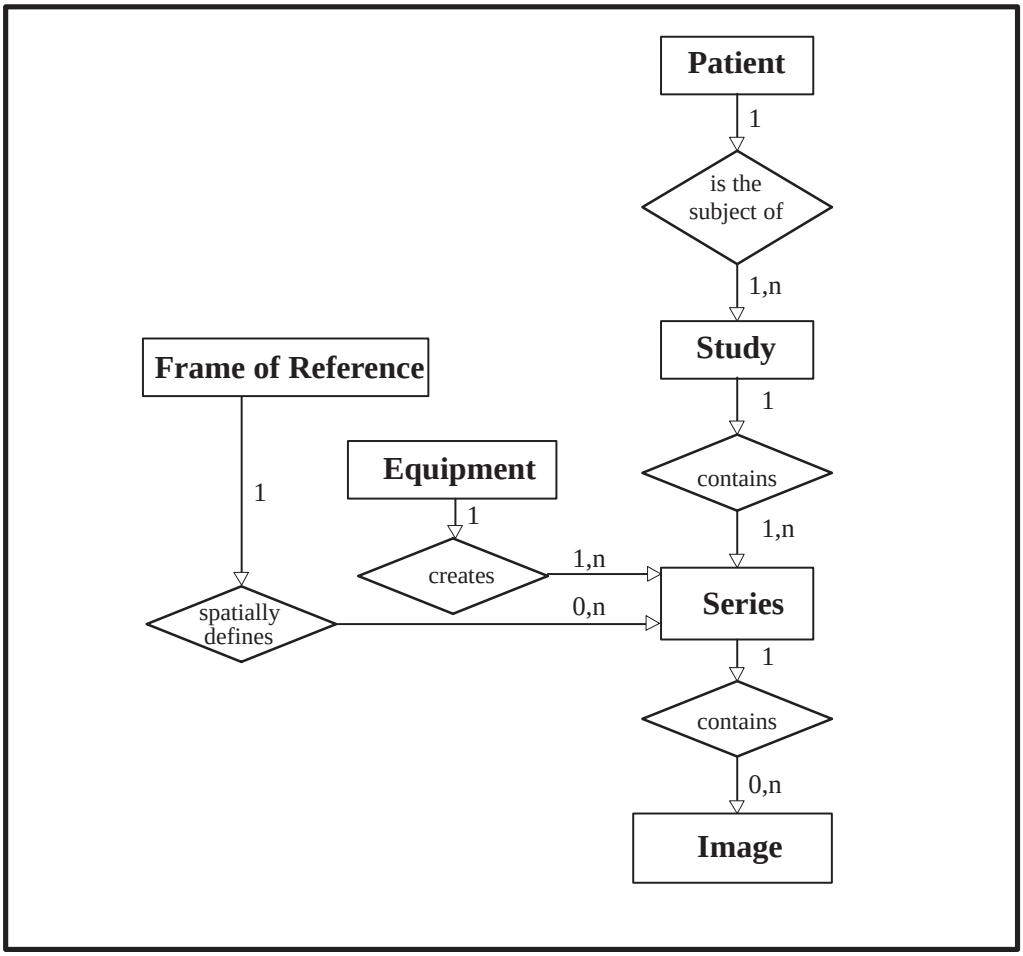
This section specifies the requirements for the DICOM CT Image IOD when being used as input to Advantage Sim.

8–1 CT Image IOD Implementation

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

8–2 CT Image IOD Entity–Relationship Model

ILLUSTRATION **4–2**
CT IMAGE ENTITY RELATIONSHIP DIAGRAM



The Entity–Relationship diagram for the CT 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.

8–2–1 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.

8–2–2 Advantage Sim Mapping of DICOM entities

DICOM entities map to the Advantage Sim entities in the following manner :

DICOM	Advantage Sim
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

8–3 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 3–2 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 3–2
CT IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	8–4–1–1
Study	General Study	M	8–4–2–1
	Patient Study	U	8–4–2–2
Series	General Series	M	8–4–3–1
Frame of Reference	Frame of Reference	M	8–4–4–1
Equipment	General Equipment	M	8–4–5–1
Image	General Image	M	8–4–6–1
	Image Plane	M	8–4–6–2
	Image Pixel	M	8–4–6–3
	Contrast/Bolus	C	8–4–6–4
	CT Image	M	8–4–6–5
	Overlay Plane	U	8–4–6–6
	VOI LUT	U	not used
	SOP Common	M	8–4–6–7

8–4 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.

8–4–1 Patient Entity Modules

8–4–1–1 Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	2	Used for display if provided. REQUIRED FOR SAFE PATIENT IDENTIFICATION.
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.

8–4–2 Study Entity Modules

8–4–2–1 General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	Used by Advantage Sim 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	REQUIRED BY ADV SIM FOR IMAGE IDENTIFICATION (MUST NOT BE ZERO–LENGTH). The values of (Study ID, Series Number) pair must uniquely identify series in Advantage Workstation database.
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.

8–4–2–2 Patient Study

Attribute Name	Element Tag	TP	Notes
Admitting Diagnoses Description	(0008,1080)	3	Used by AW if provided.
Patient's Age	(0010,1010)	3	Used by AW 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.

8–4–3 Series Entity Modules

8–4–3–1 General Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	Not used.
Series Instance UID	(0020,000E)	1	Used by Adv Sim for RT Structure Set creation.
Series Number	(0020,0011)	2	Used for image identification if provided. REQUIRED IF MULTIPLE CT SERIES ARE TO BE REFERENCED FOR THE SAME STUDY. The values of (Study ID, Series Number) pair must uniquely identify series in Advantage Workstation database.
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 AW if provided.
Operators' Name	(0008,1070)	3	Used by AW if provided.

Body Part Examined	(0018,0015)	3	Used by AW if provided.
Patient Position	(0018,5100)	3	Used by Adv Sim for patient model reconstruction. If absent, Adv Sim defaults to ”HFS” after user confirmation. GE STRONGLY RECOMMENDS THAT THIS ATTRIBUTE BE SYSTEMATICALLY PROVIDED.

8–4–4 Common Frame Of Reference Entity Modules

8–4–4–1 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.

8–4–5 Equipment Entity Modules

8–4–5–1 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.

8–4–6 Image Entity Modules

8–4–6–1 General Image

Attribute Name	Element Tag	TP	Notes
Image Number	(0020,0013)	2	REQUIRED BY ADV SIM FOR IMAGE IDENTIFICATION. MUST NOT BE ZERO LENGTH.
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	See CT Image Module.
Acquisition Date	(0008,0022)	3	Used by AW if provided.
Acquisition Time	(0008,0032)	3	Used by AW if provided.

8–4–6–2 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	Used by AW if provided. ADV SIM USES IMAGE POSITION (PATIENT) TO IDENTIFY Z COORDINATE.

8–4–6–3 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	Used for patient model reconstruction.
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.

8–4–6–4 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.

8–4–6–5 CT Image

Attribute Name	Element Tag	TP	Notes
Image Type	(0008,0008)	1	Used by AW.
Samples per Pixel	(0028,0002)	1	Used by AW.
Photometric Interpretation	(0028,0004)	1	Only MONOCHROME2 images are handled by Advantage Sim.
Bits Allocated	(0028,0100)	1	Used for patient model reconstruction.
Bits Stored	(0028,0101)	1	Used for patient model reconstruction.
High Bit	(0028,0102)	1	Used for patient model reconstruction.
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	Used by AW if provided.
Gantry/Detector Tilt	(0018,1120)	3	Used by AW if provided. Images with Gantry Tilt are rejected by Adv Sim – see Image Orientation (Patient) attribute.
Exposure Time	(0018,1150)	3	Used by AW if provided.
X–ray Tube Current	(0018,1151)	3	Used by AW if provided.
Convolution Kernel	(0018,1210)	3	Used by AW if provided.

8–4–6–6 Overlay Plane (not mandatory)

Attribute Name	Element Tag	TP	Notes
Rows	(60xx,0010)	1	Used by AW if Overlay Plane Module present.
Columns	(60xx,0011)	1	Used by AW if Overlay Plane Module present.
Overlay Type	(60xx,0040)	1	Used by AW if Overlay Plane Module present.
Origin	(60xx,0050)	1	Used by AW if Overlay Plane Module present.
Bits Allocated	(60xx,0100)	1	Used by AW if Overlay Plane Module present.
Bits Position	(60xx,0102)	1	Used by AW if Overlay Plane Module present.
Overlay Data	(60xx,3000)	1C	Used by AW if provided. **Overlays are burned into the pixel data of the image before storage in the AW database.**

8–4–6–7 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	Used by Adv Sim to confirm image is CT Image.

SOP Instance UID	(0008,0018)	1	Used by Adv Sim for image identification.
Specific Character Set	(0008,0005)	1C	Only the ISO_IR 100 extended character set is supported by Advantage Sim.