GE Medical Systems

Technical Publications

2258131-100

Revision 0

ADVANTAGE SIM 5.0

Conformance Statement

do not duplicate

Copyright© 2000 by General Electric Co.

TABLE OF CONTENTS

Blank page.

REVISION HISTORY

REV	DATE	REASON FOR CHANGE
0	June, 2000	Initial release

LIST OF EFFECTIVE PAGES

PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER
Title page	0				
i thru iv	0				
Direction 2118780	0				
2278955–100	0				

Blank page.

GE Medical Systems

Technical Publications

Direction 2118780

Revision 0

Introduction to the Integrated Dicom/Network V3.0 (ID/NET V3.0)

Conformance Statement

do not duplicate

Copyright© 1996 by General Electric Co.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

REVISION HISTORY

REV	DATE	REASON FOR CHANGE
0	August 31, 1994	Initial release to Direction Stock.

LIST OF EFFECTIVE PAGES

PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER
Title page	0				
i thru iv	0				
1–1 thru 1–10	0				
2–1 thru 2–10	0				
3–1 thru 3–10	0				
4–1 thru 4–6	0				

Blank page.

SECTION 1 – INTRODUCTION

1–1 OVERVIEW

This document is the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0)Conformance Statement*. It is applicable to all GE Medical Systems (GE) products which support the ID/Net v3.0 network. More specifically, this document is an introduction to the Conformance Statements related to GE ID/Net products.

Section 1 provides general information about the GE strategy for Open Connectivity. It includes a brief description of the relationships of GE ID/Net v3.0 and the DICOM V3.0 standards and also includes important remarks which users of ID/Net should address carefully when connecting imaging systems.

Section 2 is an overview of network architecture concepts, including the ISO seven layer model and the DICOM Applications Layer model.

Section 3 describes the basic technical concepts and terminology which are used in the DICOM standard and the ID/Net environment.

Section 4 provides some basic reference material (references, definitions, acronyms) for DICOM and ID/Net which is common to all GE DICOM Conformance Statements.

1–2 INTENDED AUDIENCE FOR THIS DOCUMENT

This document is intended for a broad audience in areas of medical imaging, software design, network planning, and/or systems integration. The reader must have a basic understanding of networking. The purpose of this document is to familiarize the reader with some of the ID/Net and DICOM v3.0 terminology and concepts.

If, however, the reader intends to work at the software implementation and/or systems integration levels, this Introduction will be helpful, but insufficient. In this case the reader must also read the DICOM v3.0 standard and the specific product Conformance Statements.

1–3 CONNECTIVITY FOR INCREASED EFFICIENCY

Connectivity is desirable for a number of reasons since it may provide clinical benefits and may increase the following departmental efficiencies:

- Rapid availability of images to diagnosticians and clinicians.
- Ease of exchange of images between locations (remotely or locally).
- Ease of image access for filming, reading, archiving (off–loading the tasks from scanners), or advanced analysis (3D, DentaScan).
- Integration of image acquisition and diagnostic information into the hospital information system, a necessary step toward patient record consolidation.

The benefits of shared digital information may include simultaneous access of information by multiple users, post processing of image data, reduction in film loss, reduction in film storage space, etc., which may result in increased productivity, efficiency, cost-effectiveness, and improved patient care. To pursue these potential benefits the concept of “Networked systems” must be incorporated. Fully networked systems are capable of **interoperating** to communicate image and related information. Simply being connected to a network does not mean that two devices can interoperate, that is, send, receive, display, analyze, or archive data, etc. ID/Net provides the interoperability foundation for networked devices, thus allowing customers to begin to choose equipment optimized for a particular application.

1–4 THE NEED FOR A STANDARD

True connectivity requires the definition and implementation of a common network communications standard among manufacturers, one that addresses a wide variety of imaging components – image acquisition equipment, display workstations, archiving systems, hard copy devices and information management systems, for example.

DICOM has emerged as the medical information networking standard, currently defining CT, MR, Nuclear Medicine, Ultrasound and Computed Radiography images, as well as Laser Camera and HIS/RIS interfaces. Also, the definition of X–Ray Angiography and Media Interchange is well underway. The development of DICOM has been the result of joint effort between NEMA (Medical Imaging Vendors) and the ACR (American College of Radiology). Other medical specialties have also contributed to this effort, in particular the ACC (American College of Cardiology).

DICOM is also a global standard. In particular, CEN in Europe is actively involved in the definition of DICOM standards and has decided to use DICOM as the basis for a European Standard. An active liaison also exists with the JIRA and IS&C committees in Japan. GE has been a major contributor to the development of this standard, and implementation of these DICOM concepts is realized in the GE ID/Net v3.0.

1–5 ID/NET – AN OPEN, INTEGRATED INTERFACE

The GE Integrated DICOM/Network v3.0 allows users to connect among GE DICOM imaging systems, as well as to other manufacturers' DICOM–based products. GE ID/Net v3.0 is a DICOM–based implementation which provides a common, open networking approach for medical imaging equipment. ID/Net is the **interoperability foundation** for a wide range of GE products and for interfacing with third party devices.

ID/Net provides the flexibility to configure, in many cases, network solutions that meet GE customers' diverse communication requirements. ID/Net also inherently provides for the option of purchasing standard network devices, such as cabling, transceivers, modems, routers, bridges, etc., to meet most network needs.

Because ID/Net is based upon networking standards, the size and configuration of health care site networks are flexible. The networking standards allow different technologies to be employed (e.g., wide area networks, local area networks, etc.).

With GE and ID/Net, you have the ability to begin accessing the benefits of connectivity today – and a solid link to the future.

1–5–1 ID/Net – An Integrated Network

ID/Net is *integrated*. DICOM standards are an integral part of product design, so investment in costly and complex gateways often needed to network between dissimilar proprietary networks is not likely (some older equipment may be an exception.)

1–5–2 ID/Net – An Open Network

ID/Net is *open*. It enables connectivity to other manufacturers' DICOM–compatible equipment. GE ID/Net interfaces are documented in DICOM Conformance Statements. If your current systems have not been built to DICOM standards, third party connections may be used to convert proprietary image format into DICOM standards.

1–5–3 ID/Net – Support by GE Products and ID/Net DICOM Conformance Statements

A number of GE systems are already demonstrating the effectiveness of ID/Net v2.0 and/or ID/Net v3.0 connectivity. Among them are our CT 9800, HiLight and HiSpeed Advantage systems, as well as MR Signa 5.X systems, Advantage Independent Consoles, and Advantage Windows workstations. As the DICOM standard evolves, additional modalities and connections are expected to be implemented.

For more specific information regarding current product capabilities and availability, please contact your GE Sales representative.

For the purposes of backward compatibility, the CT Advantage, MR Signa 5.x Advantage, and CT9800 ID/Link II continue to support ID/Net v2.0. This continuum in network connectivity is presented in section 1–5–4.

Any GE equipment which supports ID/Net will have a "DICOM Conformance Statement" available to the public. The Conformance Statement is an implementation profile which lists the DICOM functions (e.g., send a CT image, send an MR image, query for images, etc.) which have been implemented by a particular piece of equipment.

The DICOM standard, and thus ID/Net, is structured such that each device can implement the appropriate functions of the standard for its intended application. In order for two devices to interoperate, both devices must have a complementary set of functions implemented. As part of the standard, two devices negotiate before they begin to communicate to verify that the common function(s) does exist. However, before attempting to interoperate, the existence of a set of common functions should be determined by reviewing the Conformance Statement of each device. For example, a product could implement the "image send" function, but not the "image receive" function.

The exact technical specification of how ID/Net v3.0 implementations conform to DICOM v3.0 is given in each GE product ID/Net DICOM Conformance Statement. It is the intent of this document ("Introduction to the ID/Net v3.0 Conformance Statement") to provide introductory information which is common and applicable to all ID/Net DICOM Conformance Statements.

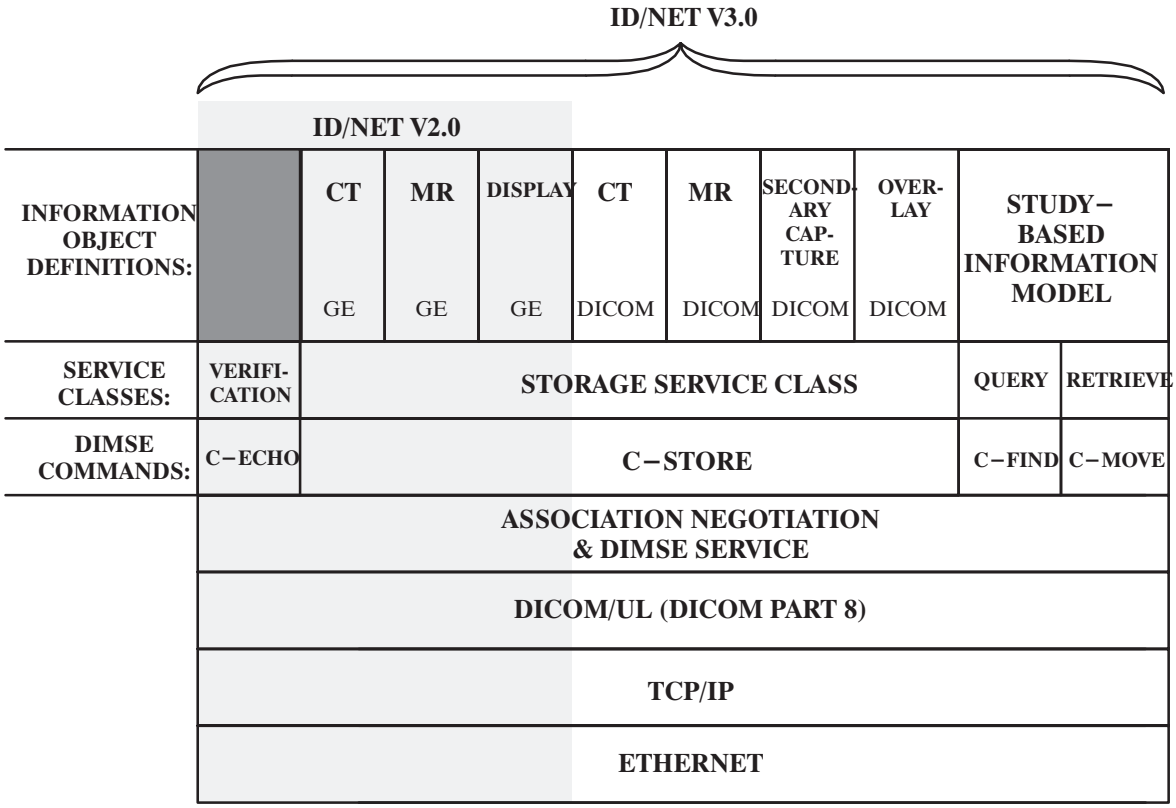
The Conformance Statements may be ordered by specifying the Direction number, as defined in the "Overall ID/Net Documentation Structure", section 1–7.

1–5–4 ID/Net v3.0 Compatibility with ID/Net v2.0

ID/Net v2.0 products were released before the DICOM Standard was completed. ID/Net v2.0 is a network protocol based on the DICOM Part 8 network communications specification, but with GE specific Information Object Definitions (IOD's). The GE IOD's are publicly available as the "ID/Net v2.0 Implementation Profiles", Direction 46–269546G2, and are based on the April 1993 draft version of DICOM v3.0.

ID/Net v3.0 is fully compliant with the final version of DICOM v3.0, but also backward compatible with ID/Net v2.0 as shown in Illustration 1–1.

ILLUSTRATION **1–1**
ID/NET V2.0 – ID/NET V3.0 RELATIONSHIP



1–6 IMPORTANT REMARKS

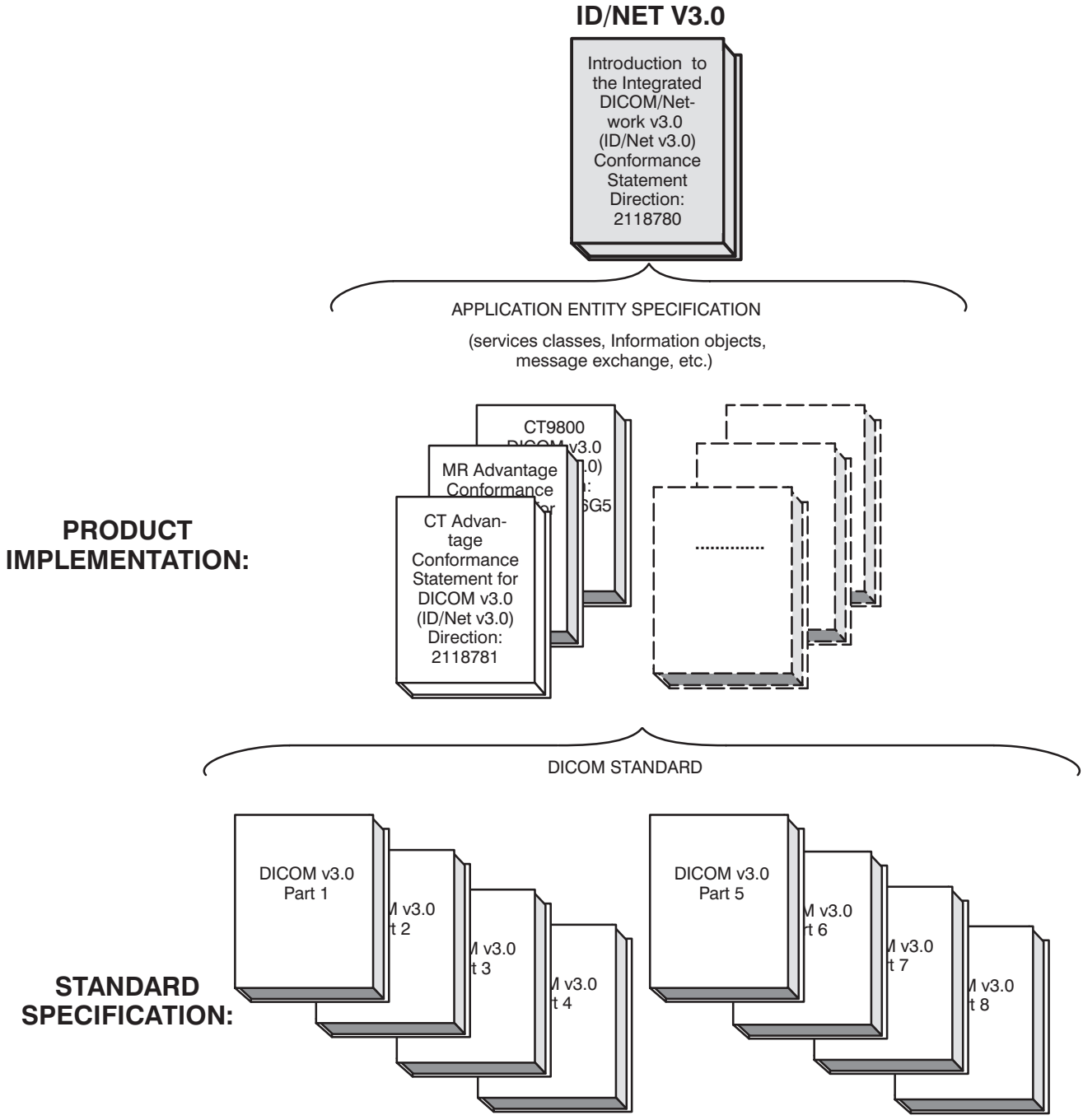
The use of these Conformance Statements, in conjunction with the DICOM v3.0 Standards, is intended to facilitate communication with GE imaging equipment. However, **by itself, it is not sufficient to ensure that inter–operation will be successful.** The **user (or user's agent)** needs to proceed with 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 Conformance Statements when interoperability with non–GE equipment is desired. The responsibility to analyze the applications requirements and to design a solution that integrates GE imaging equipment with non-GE systems is the **user's** responsibility and should not be underestimated. The **user** is strongly advised to ensure that such an integration analysis is correctly performed.
- **Validation** – Testing the complete range of possible interactions between any GE device and non-GE devices, before the connection is declared operational, should not be overlooked. Therefore, the **user** should ensure that any non-GE provider accepts full responsibility for all validation required for their connection with GE devices. This includes the accuracy of the image data once it has crossed the interface between the GE imaging equipment and the non-GE device and the stability of the image data for the intended applications.
  Such a validation is required before any clinical use (diagnosis and/or treatment) is performed. It applies when images acquired on GE imaging equipment are processed/displayed on a non–GE device, as well as when images acquired on non–GE equipment is processed/displayed on a GE console or workstation.
- **Future Evolution** – GE understands that the DICOM Standard will evolve to meet the user's growing requirements. GE is actively involved in the development of the DICOM v3.0 Standard. DICOM v3.0 will incorporate new features and technologies and GE may follow the evolution of the Standard. ID/Net v3.0 is based on DICOM v3.0 as specified in each ID/Net DICOM 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 ID/Net DICOM Conformance Statements.** The **user** should ensure that any non-GE provider, which connects with GE devices, also plans for the future evolution of the DICOM Standard. Failure to do so will likely result in the loss of function and/or connectivity as the DICOM Standard changes and GE Products are enhanced to support these changes.
- **Interaction** – It is the sole responsibility of the **non-GE provider** to ensure that communication with the interfaced equipment does not cause degradation of GE imaging equipment performance and/or function.

1–7 OVERALL ID/NET DOCUMENTATION STRUCTURE

The Documentation Structure presented in Illustration 1–2 (next page) shows the overall organization of the ID/Net documentation.

ILLUSTRATION **1–2**
DOCUMENTATION STRUCTURE



1–7–1 ID/Net v3.0 Documentation

This document focuses upon the ID/Net DICOM v3.0 Conformance Statements and provides references to the ID/Net v2.0 Implementation Profiles. This document is the introductory level document:

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

This Introduction is applicable to all ID/Net v3.0 GE products. It is intended to familiarize the reader with ID/Net v3.0 and DICOM v3.0 terminology and general concepts. This document should be read prior to reading the product specific ID/Net DICOM Conformance Statements.

For the convenience of software developers, this Introduction and all of the currently published ID/Net DICOM Conformance Statements may be ordered under a single reference:

ID/Net v3.0 Conformance Statements
Direction: 2117016

1–7–2 ID/Net v2.0 Documentation

ID/Net v2.0 documentation followed a similar structure. In cases where installed equipment not yet upgraded to ID/Net v3.0 needs to be networked, the ID/Net v2.0 documentation (Implementation Profiles) include complete conformance statements. The following documents may be ordered:

CT Advantage
Implementation Profile for ACR-NEMA v2.0
with DICOM v3.0 Extensions (ID/Net v2.0)
Direction: 46-269546G3

MR Advantage
Implementation Profile for ACR-NEMA v2.0
with DICOM v3.0 Extensions (ID/Net v2.0)
Direction: 46-269546G4

CT 9800
Implementation Profile for ACR-NEMA v2.0
with DICOM v3.0 Extensions (ID/Net v2.0)
Direction: 46-269546G5

For the sake of convenience, the ID/Net v2.0 documentation can be ordered under a single direction number:

ID/Net v2.0 Implementation Profiles
Direction 46-269546G2

Blank page.

SECTION 2 – NETWORK ARCHITECTURE CONCEPTS

2–1 OVERVIEW

The second part of this document describes some of the Network Architecture concepts and models which are used in ID/Net v3.0 and DICOM v3.0. ID/Net v3.0 is fully based upon DICOM v3.0.

2–2 BASIC NETWORK LEVELS AND PROTOCOLS

A successful network architecture must be layered to facilitate integration of evolving technologies. The Open Systems Interconnection (OSI) Reference Model defined by the International Standards Organization is the accepted seven layer model for the design of modular network architectures.

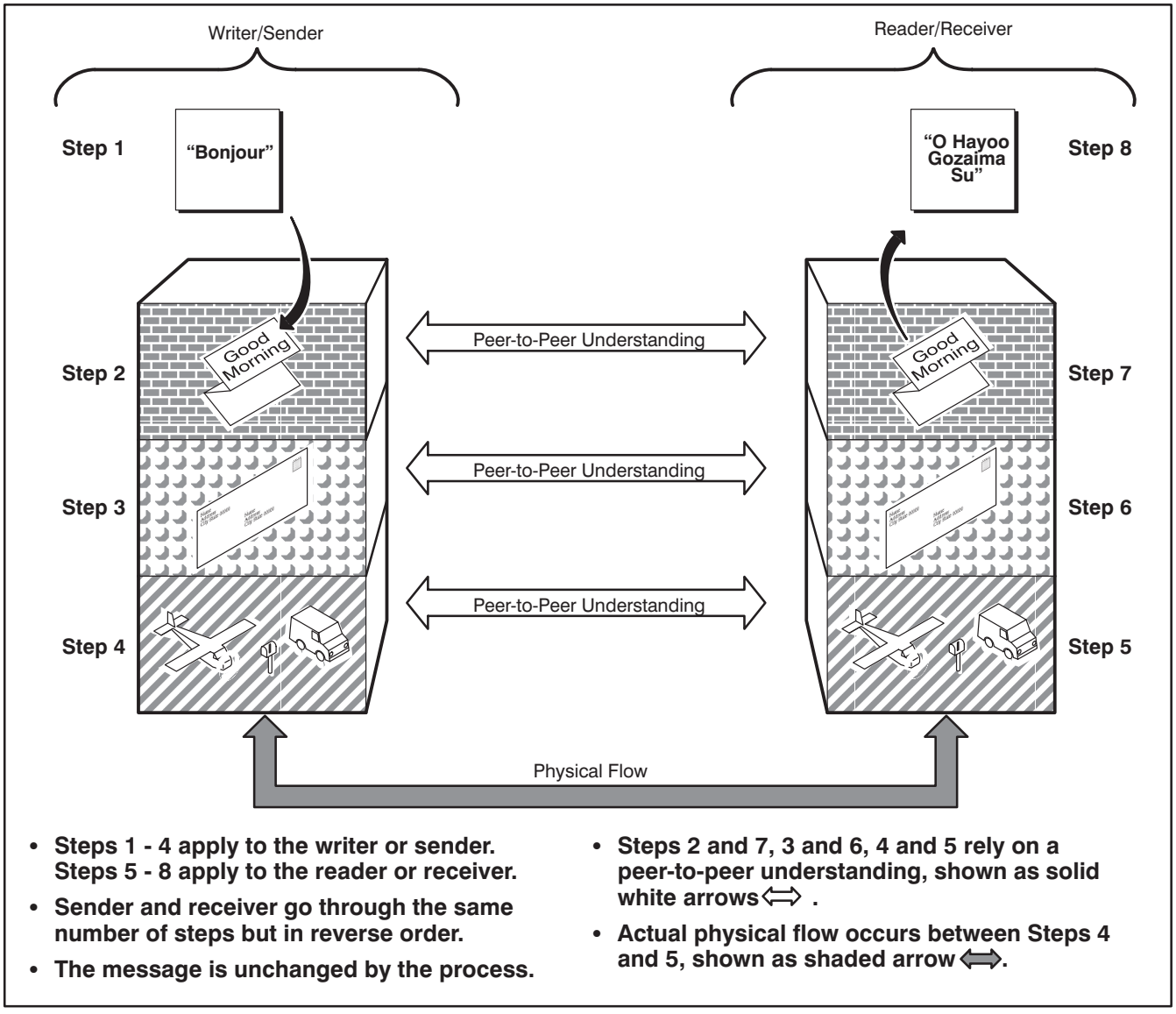
The purpose of this Section is to provide a brief explanation of the OSI networking architecture. Section 2–2–1 provides some analogies to introduce these concepts. Section 2–2–2 illustrates how DICOM is based on the OSI reference model.

2–2–1 Network Architecture and the Post Office Analogy

The fundamental choices made by the DICOM v3.0 Standard can be understood by comparing a digital medical image network to a postal system. A postal system is complex, employing computers to track and route mail, and trucks, trains, and airplanes to move mail. But for the end user, the complexity of the system is transparent.

When it comes to the content of the envelope, the two people who want to communicate need a common language for writing the letter. If they do not speak the same language but both know a third language, the third language would be the common language, the language of communication. For example, if a French person and a Japanese person both spoke English and they wanted to write to each other, they would go through this process (refer to Illustration 2–1 as you read the steps below it):

ILLUSTRATION **2–1**
GETTING THE MESSAGE ACROSS

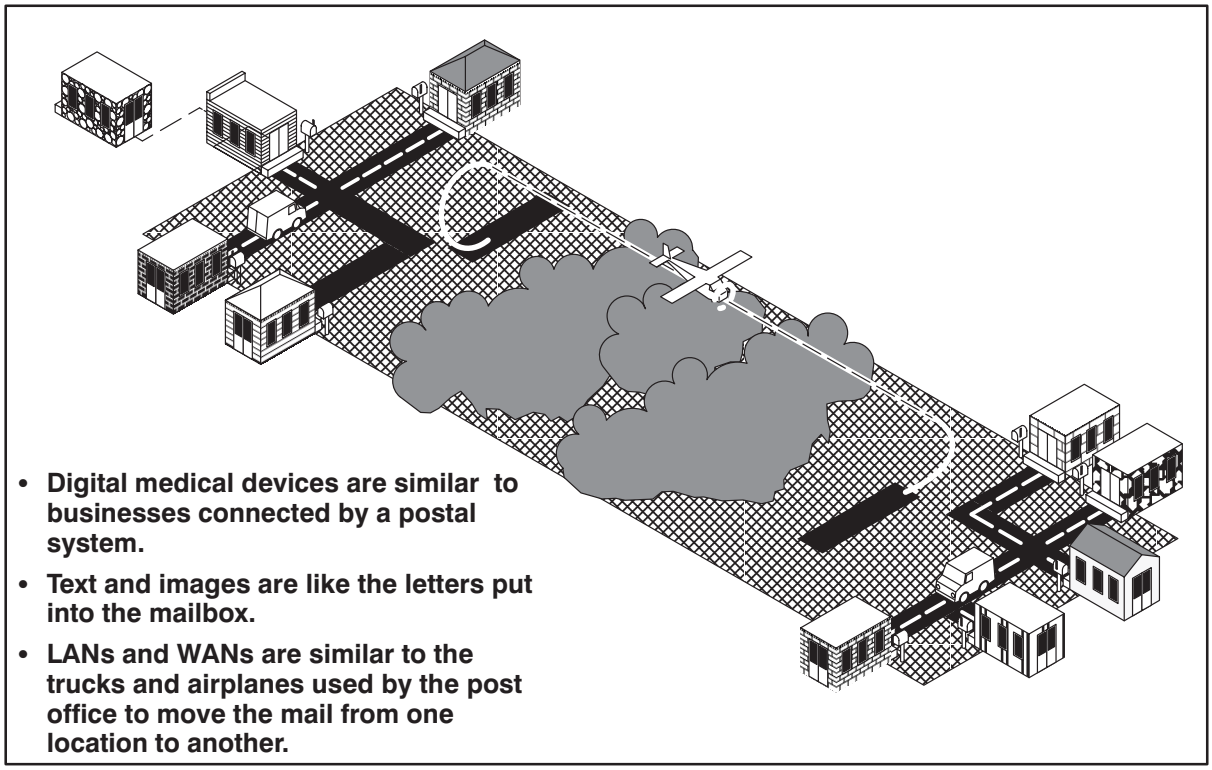


1. The letter is composed in the writer's native language, for example, French.
2. The letter is translated into English.
3. The letter is inserted into an envelope, and the envelope is addressed to meet the postal system's requirements.
4. The letter is put into a mail box, picked up by the writer's post office and sent across town or around the world.
5. The letter is received by the reader's post office.
6. The address on the envelope is read, and the letter is delivered to that address.
7. The letter is opened and read in English.
8. The English is translated into the reader's native language, for example, Japanese.

After packaging and addressing a letter and putting it into a mailbox, the postal system takes over and performs Steps 4 and 5. The letter could travel by truck, train or plane. The method of transportation does not matter as long as the letter is reliably delivered to its destination. Refer to Illustration 2–2 as you read the following:

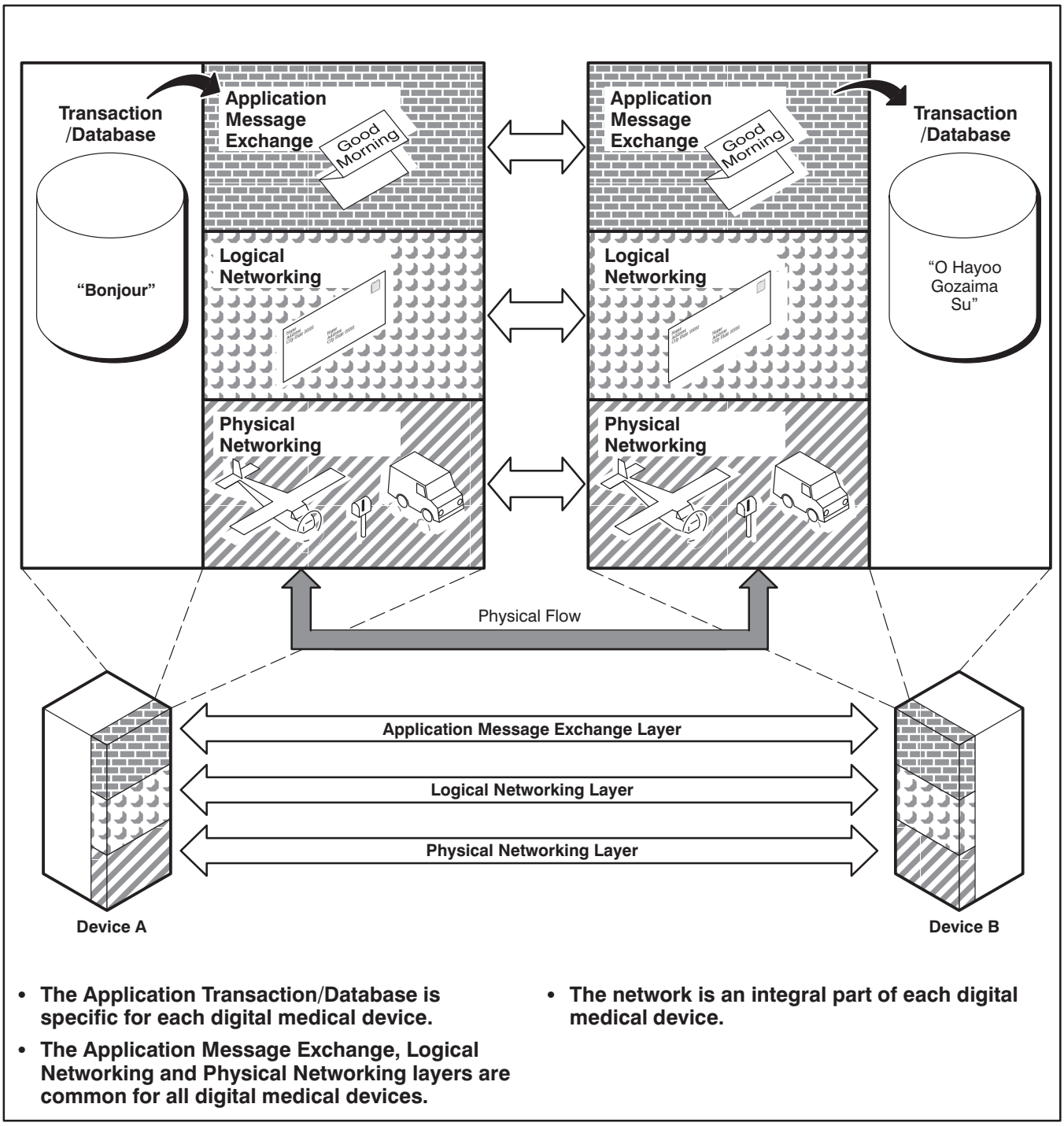
- The devices on a digital medical network are similar to the businesses on a postal system. Just as each business is different, the devices can be different. They include workstations, image acquisition devices, information systems, image storage and distribution control devices, gateways, hard copy printers and other peripherals.
- The imaging and text data being transferred across a digital medical network varies, just as the contents of letters being carried by the postal system varies. The postal system does not care about the contents of the letters it delivers, nor does it alter the contents. In a similar manner, digital medical networks should transfer image and text data without altering the information.
- The postal system delivers both small envelopes and large packages. In the same manner, a digital medical network should reliably transfer a few bytes to megabytes of data.
- The postal system employs different methods of transportation to move the mail in an efficient and cost effective manner, including people, trucks, trains and airplanes. In the same way, digital medical networks should integrate different transmission technologies to get the job done:
  - Within the hospital, digital medical networks may support different types of Local Area Networks (LANs). For example, Ethernet, Fiber Distributed Data Interface (FDDI), Digital Links, Dial–up circuits, etc.
  - When communicating outside a hospital, a digital medical network should integrate Wide Area Networks (WANs) links. These links are in general provided by regional or national telecommunication carriers who use a combination of terrestrial, microwave and satellite technologies. A wide range of service and speeds are available ranging from kilobit per second phone lines to megabit per second leased lines and switched high speed services.

ILLUSTRATION **2–2**
POSTAL SYSTEM COMPARED TO A DIGITAL MEDICAL NETWORK



When digital medical devices need to “get the message across”, they communicate using the same steps as the businesses of the postal system. The sending and receiving digital medical devices should match at all levels of networking to guarantee efficient and reliable delivery of data. The three layers of networking and the application they support are defined immediately following Illustration 2–3.

ILLUSTRATION **2–3**
PARALLEL STRUCTURE OF NETWORKED DEVICES



- **The Application Transaction/Database is specific for each digital medical device.**
- **The Application Message Exchange, Logical Networking and Physical Networking layers are common for all digital medical devices.**
- **The network is an integral part of each digital medical device.**

- The application **Transactions and Database** are like the contents of a letter written in the native language. They are specific to each device, just as the usage of the contents of a letter is specific to each reader and writer. The DICOM v3.0 Standard only addresses the network communications functions and data necessary to support the applications. It does not specify the internal design of the device.
- The **Application Message Exchange** layer is similar to the translated letter. Using DICOM v3.0, this layer allows non-compatible platforms and applications to communicate by defining common protocols and formats which support such features as image transfer, database queries and retrieval of images/text related information.
- The **Logical Networking** layer is similar to the letter's packaging and labeling. This layer defines how the message will be managed by the network and guarantees reliable delivery within a hospital and remote hospitals. The Logical Networking layer shields the Application Message Exchange layer from physical network technologies.
- The **Physical Networking** layer is similar to the trucks, trains and airplanes which transport the letter. It is the physical medium (i.e. cabling) and its access methods (access hardware and intermediate switches) such as Ethernet, FDDI, etc., which exchanges the bits of data. The Physical Networking layer should support a choice of options in order to address, in a cost effective manner, the various performance requirements of the Logical Networking layer.

The Logical and Physical Networking layers must work together to support the Application Message Exchange layer. To guarantee interoperability between devices, one approach must be specified for each layer. The selection of these choices establishes a network architecture.

Networking support is an integral part of any digital medical device. The Physical Network which externally links the device is a small component of what is required for devices to actually interoperate. The Logical Networking and Application Message Exchange functions which are integrated into the medical devices play a role transparent to the user, but fundamental to information exchange.

GE ID/Net is an open network architecture as it relies on network standards broadly supported by the medical industry (e.g., DICOM) and the computer industry (e.g., TCP/IP, Ethernet, OSI, etc.) for all of the networking layers.

2–2–2 DICOM and the OSI Reference Model

As stated earlier, DICOM v3.0 is structured according to the OSI Reference Model. The OSI Reference Model defines seven layers of communication protocol which may be more simply grouped into the three layers previously described:

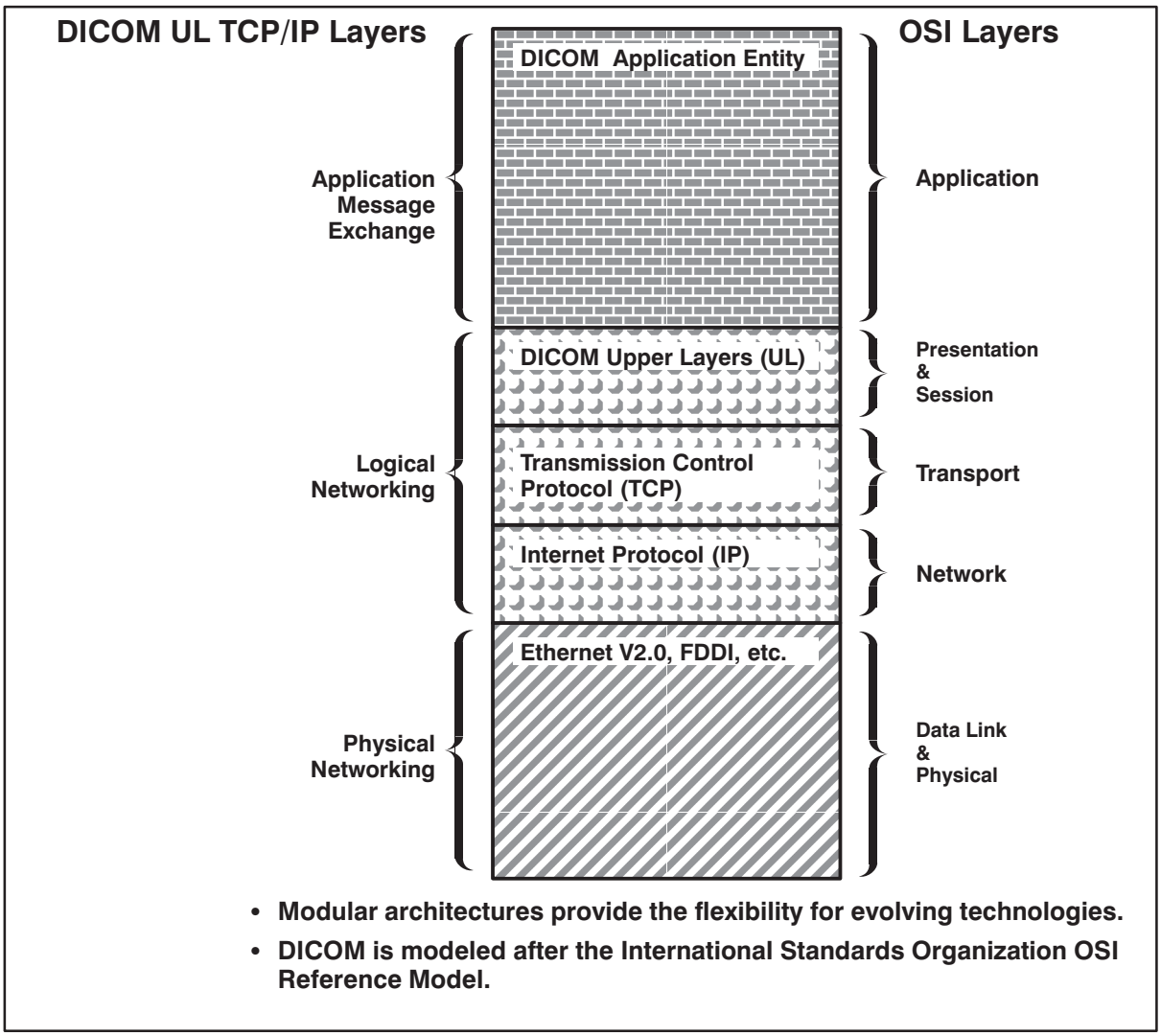
1. Application Message Exchange Layer
2. Logical Networking Layer
3. Physical Networking Layer

DICOM defines one **Application Message Exchange Layer** which may operate over two logical/physical networking protocols:

1. DICOM Upper Layers (UL) with TCP/IP
2. OSI protocol

ID/Net v3.0 has selected the DICOM UL with TCP/IP. Illustration 2–4 shows how the DICOM UL TCP/IP network protocol relates to the OSI Reference Model.

ILLUSTRATION **2–4**
DICOM UL TCP/IP AND OSI LAYERS



In the Logical Networking Layer the ID/Net architecture uses DICOM UL protocol (standardized by DICOM v3.0 Part 8) and Transmission Control Protocol/Internet Protocol (TCP/IP). TCP is a robust protocol which guarantees reliable delivery of the application messages. IP provides mechanisms which support the routing of data within a hospital or to remote hospitals over a variety of physical networks. The ID/Net Physical Networking Layer generally relies on Ethernet v2.0 as the Datalink and Physical Network Layer. Other physical network technologies may be combined with Ethernet v2.0 (e.g. FDDI or Wide Area Networks (WAN's)).

It should be noted that TCP, IP, and Ethernet are not specific to the DICOM standard and are multi-industry standards implemented in off-the-shelf commercial products. The DICOM Upper Layers (UL) and the DICOM Application Layer are specific to the DICOM standard. The DICOM Application Layer is introduced in more detail in section 3.

Blank page.

SECTION 3 – APPLICATION LAYER CONCEPTS USED IN DICOM V3.0 AND ID/NET

3–1 OVERVIEW

This section of the document describes some of the fundamental concepts and models which are used by the Application layer standardized by DICOM v3.0 and used by ID/Net Implementations. DICOM v3.0 uses Object Oriented Design concepts and the OSI Reference Model.

All parts of the DICOM v3.0 standard were unanimously approved in October of 1993. Part 10 of the DICOM Standard – Media Storage and File Formats, as well as additional parts which are under development as of early 1994, are not discussed in this section.

The reader interested in a complete presentation of these concepts should refer to the DICOM v3.0 standard. The last part in this section provides an overview of the nine DICOM v3.0 Parts.

3–2 CONFORMANCE STATEMENTS

A DICOM v3.0 Conformance Statement is available for every piece of GE Imaging Equipment having an ID/Net Interface (as is required by DICOM). The Conformance Statement explicitly states the network capabilities and options implemented by that device. For example, a Conformance Statement identifies which Information Object Definitions (MR image, Patient/Study (RIS) object, etc.) may be sent and/or received. It also identifies which Service Classes have been implemented (Storage, Query/Retrieve, Print, etc.).

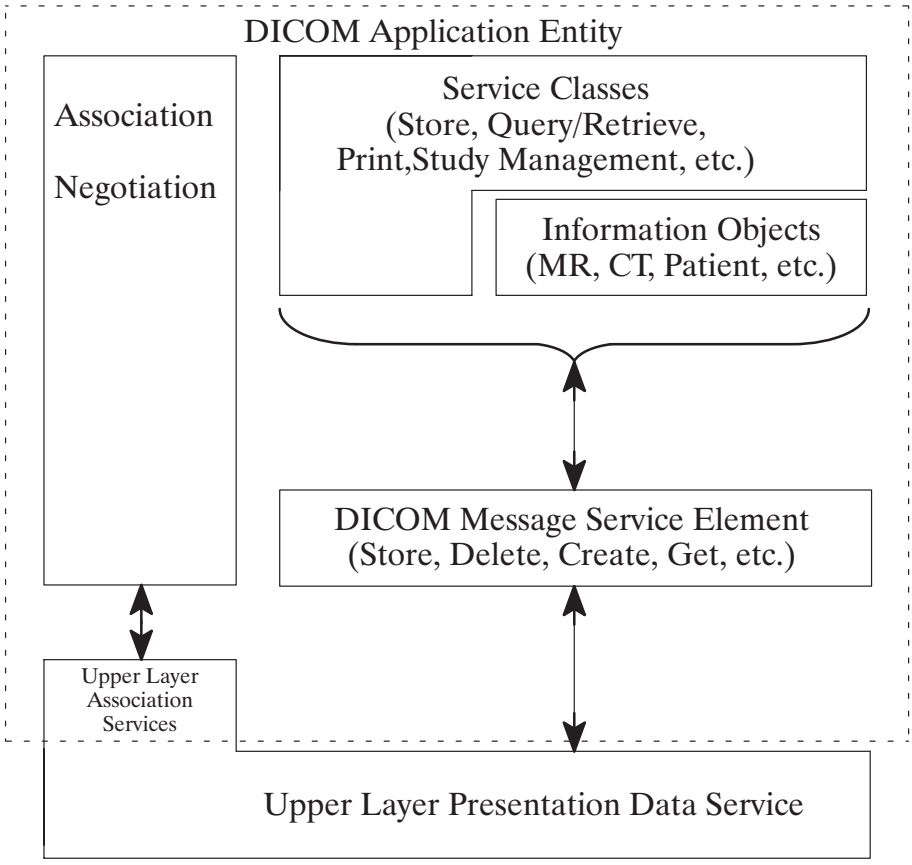
The purpose of the Conformance Statement is to define the capabilities of a specific device and allow the reader to determine what exact functionality is available. That is, Conformance Statements allow implementations to assess the level of interoperability between two DICOM compliant devices.

3–3 DICOM V3.0 APPLICATION LAYER CONCEPTS

An Application Entity (AE) is an OSI Application Layer function which includes the mechanisms by which applications exchange information on a network. The basic concepts of an Application Entity, as used in the DICOM v3.0 standard, are described in this section (see Illustration 3–1 for a pictorial representation of the DICOM Application Entity).

The DICOM model is based on an object-oriented model. Object-oriented modeling uses abstract data objects (e.g., the definition of MR images, CT images, etc.) to represent a class of real-world objects. Object-oriented modeling also defines generic "methods" (e.g., Store, Delete, Create, Get, etc.) which act upon the data objects. The combination of a method and a data object being used by two peer AEs over an association constitutes an instance of communication. Illustration 3–1 shows the relationship of the DICOM objects model.

ILLUSTRATION **3–1**
DICOM OBJECTS RELATIONSHIP MODEL



An AE uses the following concepts:

1. Information Object Definitions (data object definitions)
2. DICOM Message Service Element Services (generic methods)
3. Service Object Pair (SOP) Classes (the method and data object combined)
4. Service Classes (a set of related SOP Classes)
5. Association Negotiation (negotiate how data will be encoded and the type of data to be exchanged)

Each of these concepts is defined in further detail in sections 3–3–1 through 3–3–5.

3–3–1 Information Object Definition

An Information Object Definition (IOD) is the specification used to define an abstract data object (the information to exchange). The goal of an IOD is to provide an unambiguous specification about related pieces of information. IODs do not represent a specific instance of the data object, but rather a class of similar data objects which have the same properties. IODs provide the mechanisms to specify data objects such as images (e.g., MR, CT, NM, etc.) and also image related data objects such as curves, overlays, Radiology Information System (RIS) information, etc.

In DICOM an IOD consists of an Entity Relationship Model, information entities, modules, and attributes. The content of an IOD is similar to a memo. A memo consists of words (called attributes), sentences (a set of related words, called modules), paragraphs (a set of related sentences, called information entities), and finally the memo (a set of related paragraphs, described by an Entity Relationship Model).

3–3–2 DICOM Message Service Element (DIMSE) Services

Specifying an IOD is key for communication. However, it is not sufficient. Services (methods) which operate on IODs need to be standardized. DICOM defines a set of generic services (such as Store, Create, Delete, Get, etc.) which act upon instances of an IOD. These services are called the DICOM Message Service Element (DIMSE).

3–3–3 Service Object Pair (SOP) Class

The coupling of one or more DIMSE Services with one specific IOD results in a Service Object Pair Class (SOP Class). A SOP Class specification contains the rules which are applied to the DIMSE Services and a related IOD. A SOP Class is equivalent to an “object class” in the object-oriented model (the data plus the methods).

A SOP Class is the key specification building block for the successful communication between two AEs. However, like the IOD, the SOP Class does not represent a specific instance of communication. When a specific instance of communication does occur it is defined as a SOP Instance. SOP Instances are used to represent real-world occurrences of images, studies, patients, etc.

The analogy of a sentence can be used to describe the MR Storage SOP Class. The IOD acts as the noun (an MR image). The DIMSE Service acts as the verb (Store). The SOP Class is similar to a generic sentence (Store an MR image). The SOP Instance is similar to a specific sentence (Store this MR image).

3–3–4 Service Class

A Service Class represents a specific function which is to be accomplished by peer AEs and is defined by a set of related SOP Classes. For example, the features needed to query for image information and to retrieve the actual image data are very closely related. To achieve these features two SOP Classes are required, one to gather image information (query) and one to get the image data (retrieve). The Query/Retrieve Service Class combines these related SOP Classes into one Service Class.

The Service Class defines two roles which are used by communicating AEs, the Service Class User (SCU) and Service Class Provider (SCP). These roles are based on the “client/server model”. The SCU acts as the “client” while the SCP acts as the “server”. For example, for the Storage Service Class, the SCU acts as the image send device while the SCP acts as the image receive device.

3–3–5 Association Negotiation

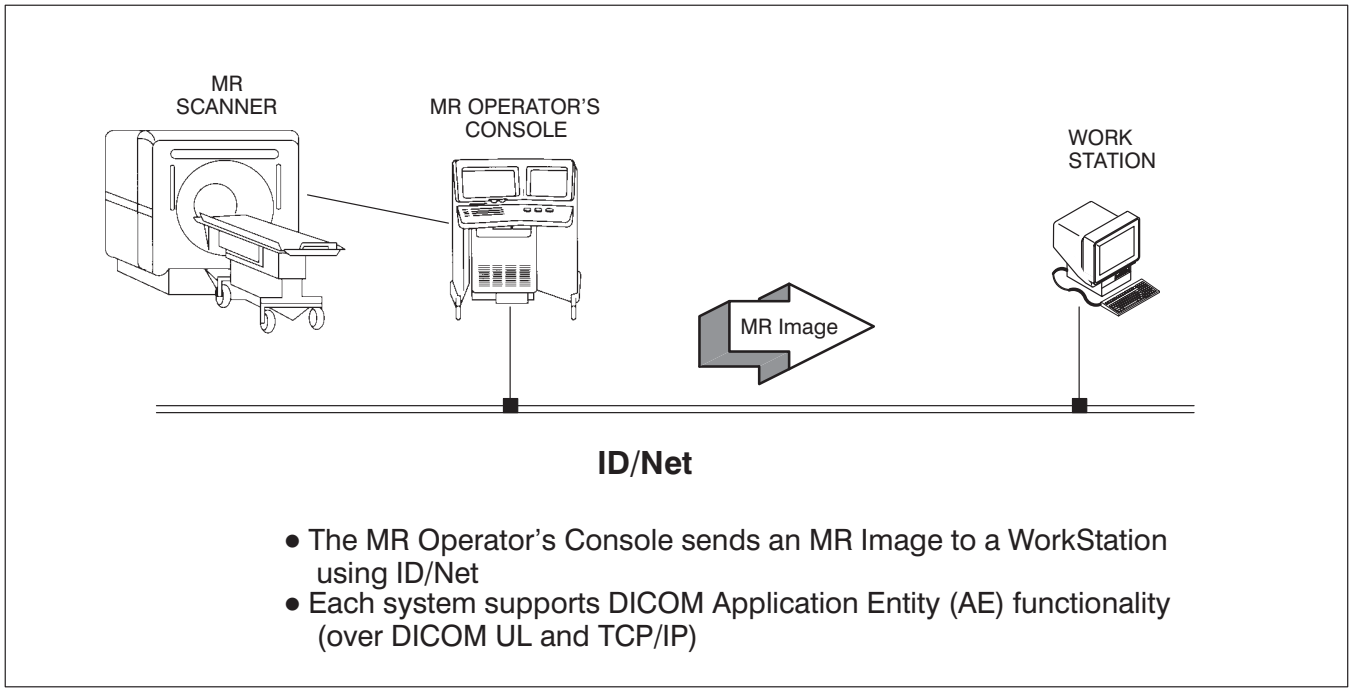
Association establishment is the first phase of communication between peer AEs. The AEs use the association establishment to negotiate how data will be encoded and the type of data to be exchanged. Some of these negotiated parameters include Application Context, Abstract Syntaxes, Transfer Syntaxes, and Application Association Information.

The method of negotiation used in DICOM v3.0 is fairly simple. The device which initiates the association proposes a list of possible options for each negotiated parameter. The initiating device must be capable of supporting all of the options which it proposes. The responding device selects which of the options it can support and returns this information to the initiating device. This commonly agreed upon set of options is then available on the corresponding association.

3–3–6 Example of AE Concepts

Following is an example of two systems which need to send/receive an MR image. This example illustrates how DICOM is used to achieve this image exchange.

ILLUSTRATION **3–2**
EXAMPLE OF AE CONCEPTS

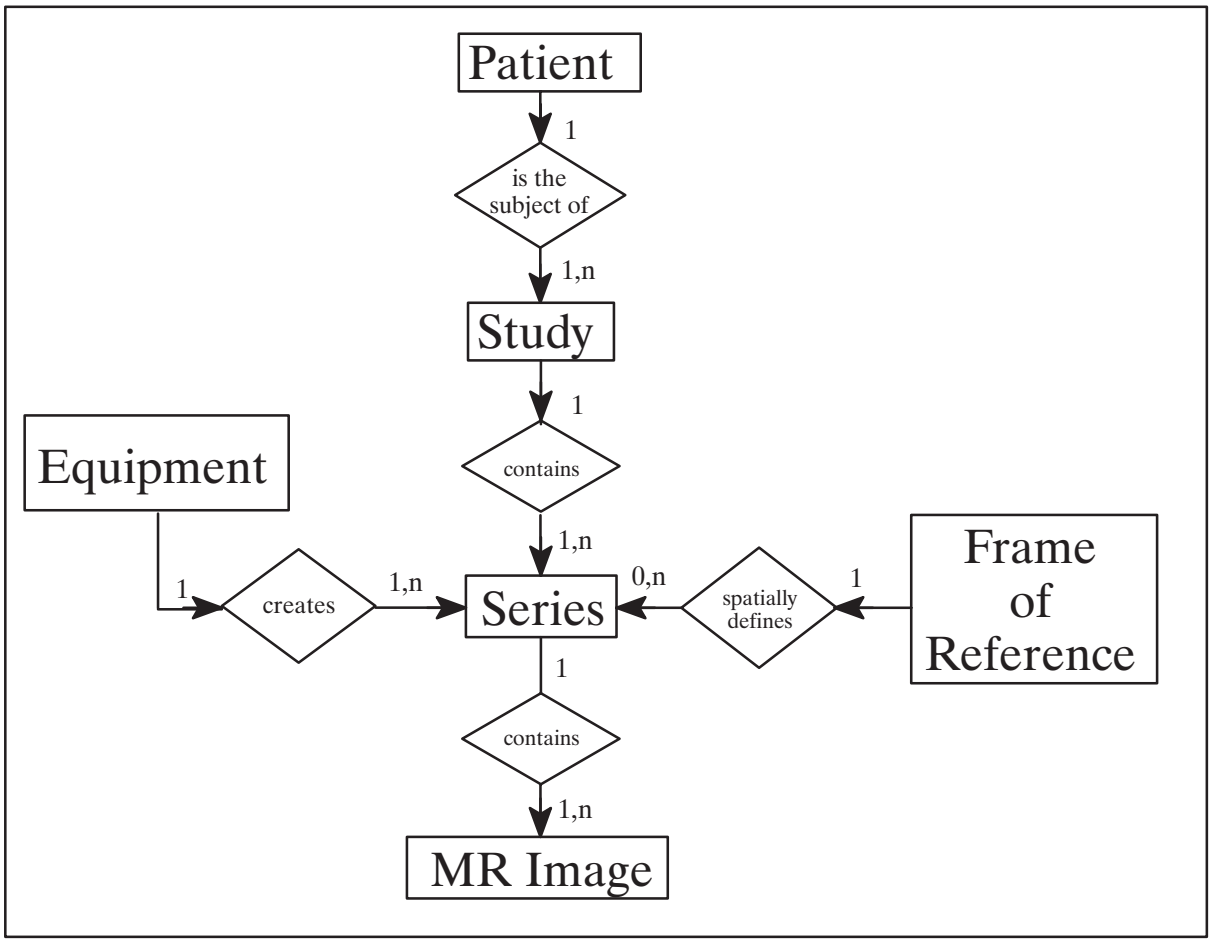


In order to understand how to exchange this MR image, both the MR Scanner and the Workstation need to implement the DICOM Application Entity concepts previously discussed.

To determine the data structure that defines an MR image each device must understand the **MR Image Information Object Definition**.

The MR Image IOD contains the **Attributes** which describe the complete set of data needed to define the image. Some of the Attributes are Patient Name, Date of Scan, MR Acquisition Type, Echo Time, Pixel Data, etc. Associated Attributes are grouped into **Modules**. Modules contain the exact definition of each Attribute, including whether the Attributes are required or optional and the rules of how these Attributes are related. A few of the Modules are: Patient Identification Module, Image Pixel Module, Overlay Plane Module, Lookup Table Module, etc. Associated Modules are grouped into **Information Entities**. The key Information Entities include Patient, Study, Series, Equipment and Image. As an example, the Image Information Entity includes the Image Pixel Module, Overlay Plane Module, and the Lookup Table Module. The relationship of the Information Entities is described by an **Entity Relationship Model** (see Illustration 3–2 for an example of an Entity Relationship Model and DICOM Standard Part 3, section 5 for information on how to interpret Entity relationship diagrams).

ILLUSTRATION **3–3**
MR IMAGE ENTITY RELATIONSHIP DIAGRAM



To determine how to send/receive the MR image each device must understand the **C–STORE DIMSE Service**. This is the generic service (method) which is used to send or receive any image, e.g., MR, CT, Nuclear, etc.

To determine how to couple the MR Image IOD and the C–STORE DIMSE Service each device must understand the **MR Storage SOP Class**. In this example, only one DIMSE Service is coupled with the MR Image IOD. However, other examples may include multiple DIMSE Services coupled with one IOD.

The MR Storage Service Class is one of the SOP Classes specified by the DICOM Storage Service Class. Each AE must understand which role it wishes to play for the MR Storage SOP Class. The MR Scanner, which is sending the image, will act as the **Storage Service Class User** (SCU). The Workstation, which is receiving the image, will act as the **Storage Service Class Provider** (SCP).

To establish an **Association** between the two devices so the image may be sent, both AE's must understand the negotiation process. Two of the key parameters which will be negotiated during Association Establishment are the **Abstract Syntax** and **Transfer Syntax**. The Abstract Syntax identifies the SOP Class. In this example, the Abstract Syntax is the MR Storage SOP Class (i.e., the MR Image IOD and the C–STORE DIMSE Service). The Transfer Syntax identifies the type of pixel data encoding which will be used to send this image, e.g., compressed or uncompressed pixel data.

In this example, the MR Scanner may initiate the Association by proposing several Abstract and Transfer Syntaxes. The responding Workstation will identify the Syntaxes it can support in its response to the MR Scanner.

3–3–6–1 Communication Scenario

Now lets go through the order that the steps occur in the actual transmission of the image.

The MR Scanner first initiates an association to the Workstation. It offers an Abstract Syntax which represents the MR Storage SOP Class with two Transfer Syntaxes, compressed or uncompressed pixel data. The Workstation responds by accepting the MR Storage SOP Class and selecting the uncompressed Transfer Syntax (it could not support compression). The association is now established.

The MR Scanner constructs the image per the MR IOD and uses the C–STORE DIMSE Service to send that IOD. The result will form a message including a command (C–STORE) and a Data Set (the MR IOD encoded Attributes). The actual image or MR Image SOP Instance is identified by a unique identifier or UID (see section 3–4) .

The Workstation receives this MR Image SOP Instance and stores the information in it's database. The Workstation returns a "successful" response using the STORE DIMSE Service. The image has now been successfully received.

At this time the MR Scanner may send more images or release the association.

Notice: The above example illustrates a simple transfer of images. If both the MR Scanner and the Workstation had implemented additional SOP Classes, such as Query/Retrieve, these features could also be used on the same association.

3–4 UNIQUE IDENTIFIERS (UIDS)

Unique Identifiers (UIDs) provide the capability to uniquely identify a wide variety of items. It guarantees uniqueness across countries, sites, vendors and equipment. This scheme is used to uniquely identify items such as Service Object Pairs (SOP) Classes, images, instances, network negotiation parameters, etc.

The UID identification scheme is based on the OSI Information Object as defined by the ISO 8824 standard. All UIDs, used within the context of the DICOM Standard, are based upon registered values as defined by ISO 9843-3 to ensure global uniqueness.

There is a root portion of the UID which uniquely identifies GE Medical Systems. The root is registered with ISO and therefore guarantees that GE-specific UIDs are unique among vendors.

Per the DICOM v3.0 standard, three types of UID values are used:

1. The DICOM UID values which are defined in the DICOM Standard (such as SOP class UIDs).
2. GE-specific UID values which are defined in the ID/Net DICOM Conformance Statement for GE products (such as product Implementation Class UID's).
3. GE–specific UID values dynamically generated by GE product implementations (such as Image SOP Instance UIDs).

3–5 RELATIONSHIP OF CONCEPTS TO THE PARTS OF THE DICOM V3.0 STANDARDS

DICOM v3.0 is comprised of nine Parts which were balloted and approved in October, 1993. As of early 1994, three additional Parts related to Media Storage and File Format were placed under review. The nine Parts of the DICOM v3.0 Standard and the areas which are covered are:

PART	TITLE
1.	**Introduction and Overview**
2.	**Conformance Requirements** Includes requirements for accurately writing a DICOM Conformance Statement.
3.	**Information Objects Definitions** Includes IODs for MR, CT, Ultrasound, Nuclear, etc. It also includes IOD's for Network Filming and Imaging Study Management (often called HIS/RIS Interfacing).
4.	**Service Classes Specifications** Includes definitions of Service Class concepts, the SCU/SCP roles, and definitions of Service Classes (i.e. Image Storage, Query/Retrieve, Network Print, Study Management, Results Management, etc.).
5.	**Data Structure and Encoding** Includes DICOM data set structure, Data Element encoding rules, value encoding definitions (e.g., short string, unsigned short int, etc.). Attribute types, UID encoding rules and registration, and Transfer Syntax specifications. The support of JPEG lossless compression is also fully specified.
6.	**Data Dictionary** Includes Element list which is made up of Attribute Names and descriptions,Data Element Tags (Group and Element numbers), Value Representations and Multiplicity.
7.	**Message Exchange** Includes association negotiation information and structures, DIMSE operation and notification rules and DIMSE service and protocol definitions (e.g., C-STORE, C-ECHO).
8.	**Network Communication Support for Message Exchange** Includes Association Establishment protocol and encoding, including the DICOM Upper Layer protocol used with TCP/IP.
9.	**Point-to-point Communication** Includes 50-pin hardware specification and communication protocol. This is the ACR−NEMA specific hardware interface which was defined in Version 2 of the Standard. It has been included as Part 9 of the DICOM Standard for historical purposes.

Blank page.

SECTION 4 – REFERENCES

4–1 NORMATIVE REFERENCES

- DICOM – Part 1: Document Structure
- DICOM – Part 2: Conformance
- DICOM – Part 3: Information Object Definitions
- DICOM – Part 4: Service Class Specifications
- DICOM – Part 5: Data Structure and Encoding
- DICOM – Part 6: Data Dictionary
- DICOM – Part 7: Message Exchange
- DICOM – Part 8: Network Communication Support for Message Exchange

4–2 RELATED PUBLICATIONS OF INTEREST

- DICOM v3.0 Standard (printed copy):
  ACR–NEMA / DICOM Representative
  NEMA
  2101 L Street, NW, Suite 300
  Washington DC 20037
  USA
  (202 457–1965)
- DICOM v3.0 (electronic copy):
  Available through anonymous ftp from Pennsylvania State University
  ftp address: **ftp.xray.hmc.psu.edu**
- SCAR 1994 “Buying Imaging Products with a DICOM Interface – Made Easy”
  Van Syckle, Sippel–Schmidt, Parisot

4–3 DICOM SOFTWARE COMMONLY AVAILABLE

DICOM v3.0 Shareware (RSNA 1993 Central Test Node Software) available via anonymous ftp over internet:

- Mallinckrodt Institute of Radiology
  ftp address: **wuerlim.wustl.edu** (128.252.115.18)
- Institute OFFIS, Oldenburg University (Germany), CERIUM in Rennes, France, and CEN/TC251/WG4
  ftp address: **ftp.uni–oldenburg.de**

4–4 DEFINITIONS

Many of the terms defined here are used in sections 2 and 3 of this document and in the ID/Net DICOM Conformance Statement of each GEMS product.

Abstract Syntax: The Abstract Syntax identifies the Service/Object Pair (SOP) Class which is used when two peer DICOM Application Entities communicate. The Abstract Syntax is negotiated at the time of Association Establishment.

ACR-NEMA: A standards body sponsored by the American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA).

Application Context: An Application Context is a name which is used to identify the use of the DICOM Application Services over an association. It is negotiated between two peers during association establishment.

Application Entity (AE): An Application Entity is an OSI Application Layer function which includes the mechanisms by which applications exchange information on a network. Oversimplistically, an AE is a program which contains network communications capabilities and which runs on a computer.

Association Establishment: An Association represents a level of connectivity between to AEs. An Association Establishment is the first phase of communication between two peer DICOM AEs. The two peers use this method to negotiate some communication parameters such as Abstract Syntax, Transfer Syntax, etc.

Attributes: Attributes are properties which describe an Information Object Definition. An Attribute is identified by a name and its associated Data Element Tag (group and element number).

Conformance Statement: The Conformance Statement states which options and features of DICOM have been implemented by a specific product (e.g. which IOD's, which Service Classes, etc.). It specifies in technical detail how a particular implementation meets the conformance requirements set forth by DICOM v3.0. Every device which claims DICOM conformance must openly publish a DICOM conformance statement, written in the format specified by DICOM Part 2.

Data Element: A Data Element is an encoded Attribute and is part of a Data Dictionary. The Data Element Tag is used to uniquely identify the piece of information within the Dictionary. An Element Number is combined with a Group Number to make up a tag. For example, Study (Exam) Number is Group 20 Element 10. The group and element number tag are encoded in the Data Set (and, hence, the data stream.)

DICOM: The acronym of the final version of the standard produced by the ACR-NEMA committee is officially called: Digital Imaging and Communications in Medicine (DICOM v3.0), and was unanimously approved in October 1993.

DIMSE: DICOM Message Service Element. The DICOM v3.0 Standard defines the services and protocols used by an Application Entity to exchange messages. These services and protocols define the DICOM Message Service Element (DIMSE). DIMSE defines generic "operations" (such as Store, Move, Find, Get, etc.) which can be used in specifying SOP Classes. DIMSE are defined in DICOM v3.0 Part 7.

Element: Informal term used to reference a Data Element.

Full Fidelity Storage: The characteristic of a receiving device to be able to receive and store all attributes, including private attributes, specified for a given Image Information Object Definition.

Group: A Group is a collection of data elements within a message and is part of a Data Dictionary Tag (see Tag).

Information Entity: An Information Entity is a subset of an Information Object Definition (e.g., CT image or MR image). It is a group of related Modules.

Information Object: Informal term used to reference an Information Object Definition.

Information Object Definition (IOD): An IOD is a data model which is an abstraction of real-world information (e.g., an MR Image or CT Image) and which is acted upon by one or more DIMSE operations. An IOD consists of a data model describing the interpretation of the information and the attributes which define it.

Module: A Module is a set of Attributes within an Information Object which are logically related to each other. For example, the "Patient Identification Module" may be defined by the following attributes: Patient Name, Patient ID, and Patient Birthdate, and Patient Sex.

Service Class: A Service Class defines a specific function which is to be accomplished by connecting AEs. A Service Class specifies a set of one or more Service/Object Pairs (SOP) which perform a function across a network and provide interoperability between two application entities. Examples of a Service Class include image storage, query/retrieve, etc.

Service Class Provider (SCP): A Service Class Provider acts in a "server" role to the Service Class during a network communications exchange. An SCP performs operations requested by an SCU and may also provide notifications to the SCU. An example of a **Storage** Service Class Provider would be the image storage device. In this case, the image storage device is storing the image as requested by the SCU.

Service Class User (SCU): A Service Class User acts in a "client" role to the Service Class during a network communications exchange. An SCU requests that an SCP perform operations. An example of a **Storage** Service Class User would be the image send device. In this case, the image send device will send an image by requesting the SCP to store that image.

Service/Object Pair (SOP) Class: A SOP Class is defined by the union of an IOD and a DIMSE Service Group. The SOP Class definition contains the rules and semantics which may extend or restrict the definitions of the DIMSE Service Group or the IOD attributes. A DICOM Application Entity may support one or more SOP Classes. Each SOP Class is identified by a SOP Class UID.

SOP Instance: A representation of a specific occurrence of a SOP class.

Tag: The Tag is used to uniquely identify information within a Data Dictionary. A Group Number is combined with an Element Number to make up a tag. For example, Study (Exam) Number is Group 20 Element 10. The group and element number tag are encoded in the data stream. In v2.0, the Group was used to convey semantic information (e.g., Group 10 is Image Information). However, in DICOM v3.0 the Group semantic information has been replaced with the Module concept.

Transfer Syntax: The Transfer Syntax represents the type of data encoding which is used when two peer DICOM Application Entities communicate. The Transfer Syntax is negotiated at the time of Association Establishment. Examples of Transfer Syntaxes are Little Endian, Big Endian, JPEG lossless compression, etc.

Unique Identifier (UID): A Unique Identifier is a method which is used to create a globally unique ASCII-numeric string. It guarantees uniqueness across multiple countries, sites, vendors and equipment. The UID encoding method which is used in DICOM v3.0 is ISO compliant. A few examples for uses of UIDs are SOP Class UID, Image UID, network negotiation parameters, etc.

Upper Layer (UL): The Upper Layer is part of the DICOM Logical Network Layer of software. The Upper Layer performs such functions as the Association Establishment (including Abstract and Transfer Syntax negotiation), the encoding and decoding of a DICOM message stream, etc.

4–5 SYMBOLS AND ABBREVIATIONS

ACC	American College of Cardiology
ACR	American College of Radiology
AE	Application Entity
ANSI	American National Standards Institute
DICOM	Digital Imaging and Communications in Medicine
DIMSE	DICOM Message Service Element
GEMS	GE Medical Systems
HIS	Hospital Information System
ID/NET	Integrated DICOM/Network
IOD	Information Object Definition
IS&C	Image Save & Carry
ISO	International Standards Organization
JIRA	Japanese Industry Radiology Aparatus
NEMA	National Electrical Manufacturers Association
OSI	Open Systems Interconnection
RIS	Radiology Information System
SCP	Service Class Provider
SCU	Service Class User
SOP	Service/Object Pair
TCP/IP	Transmission Control Protocol/Internet Protocol
UID	Unique Identifier
UL	Upper Layer

Blank page.

GE Medical Systems

Technical Publications

Direction 2278955–100

Revision 0

ADVANTAGE SIM 5.0 Conformance Statement for DICOM V3.0

do not duplicate

Copyright© 2000 by General Electric Co.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

REVISION HISTORY

REV	DATE	REASON FOR CHANGE
0	June, 2000	Initial release

LIST OF EFFECTIVE PAGES

PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER
Title page	0				
i thru viii	0				
1–1 thru 1–6	0				
2–1 thru 2–14	0				
3–1 thru 3–6	0				
4–1 thru 4–8	0				
5–1 thru 5–14	0				
6–1 thru 6–18	0				
7–1 thru 7–14	0				
8–1 thru 8–8	0				

Blank page.

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 generated by Advantage Sim, and the requirements for RT Structure Set objects imported into Advantage Sim.

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 generated by Advantage Sim, and the requirements for RT Plan objects imported into Advantage Sim.

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:

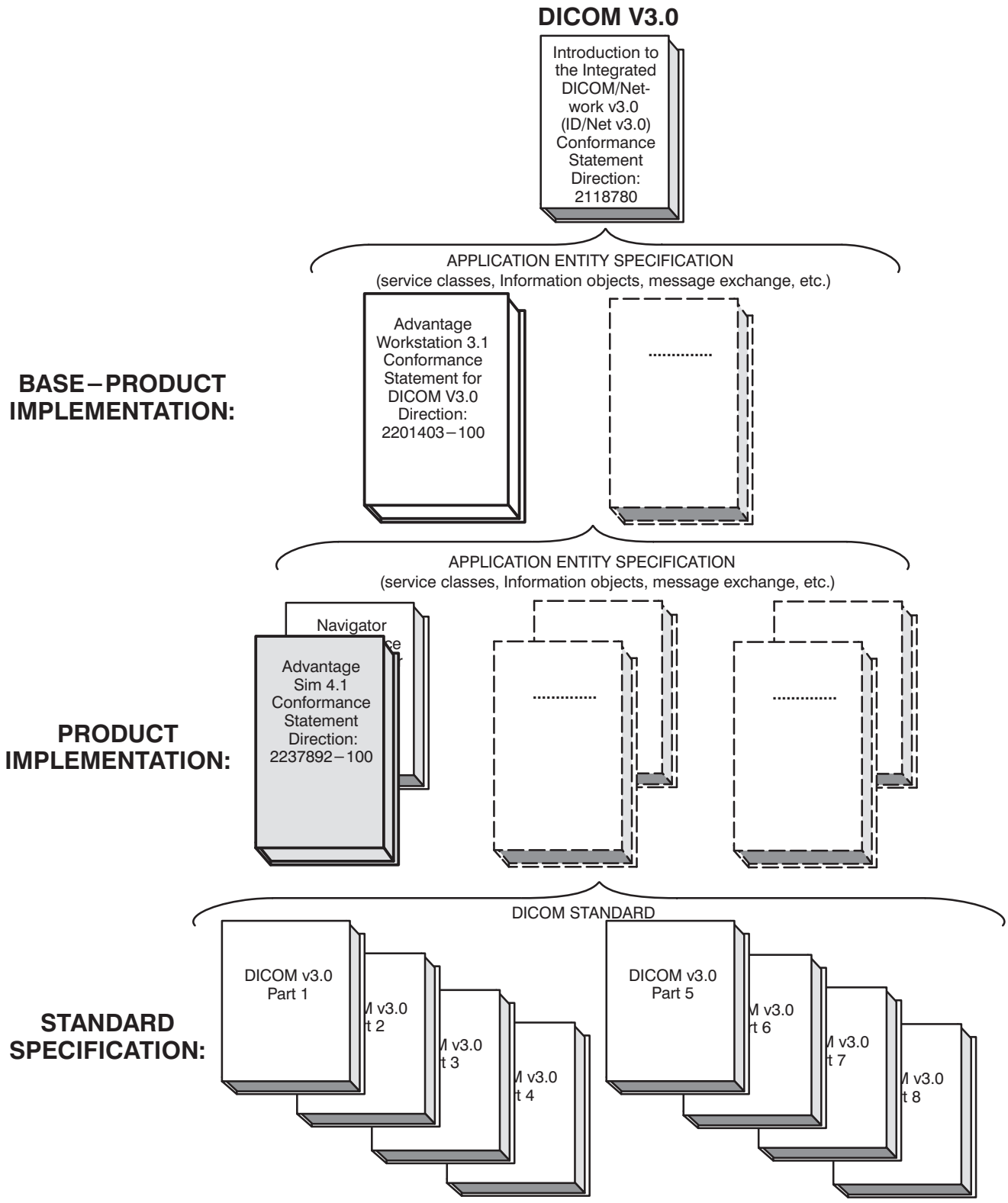
ADVANTAGE SIM 4.1
Conformance Statement
Direction .....# 2237892–100.

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).

Blank page.

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.

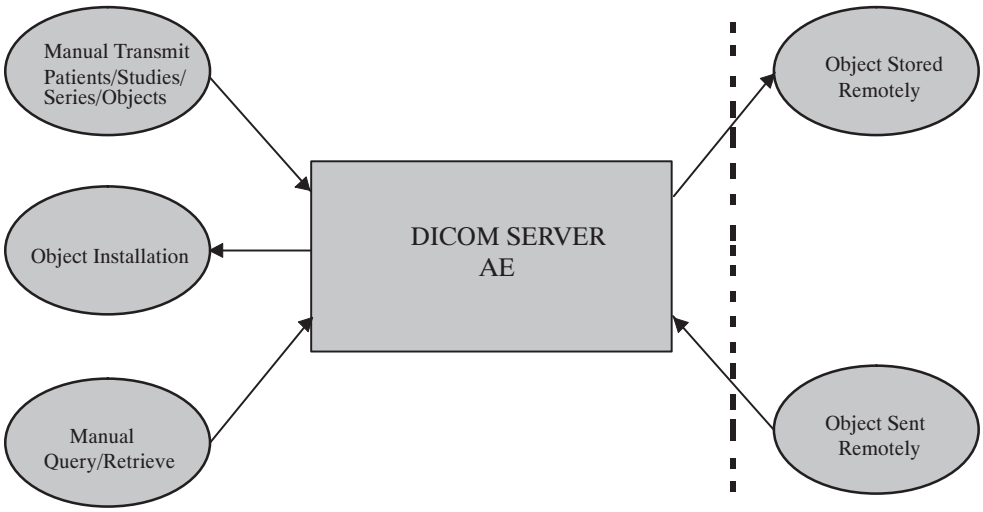
Advantage Sim is a radiotherapy virtual simulation application that is installed on the same hardware platform as the base application, Advantage Workstation. This base application is a Networked Medical Imaging Console dedicated to Examination Review and Diagnosis. The workstation uses DICOM services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

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
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
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 can be determined by examining this document in conjunction with *the Advantage Workstation 3.1 Conformance Statement for DICOM V3.0, Direction: 2201403-100*.

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 Advantage Sim 4.0 is 1.2.840.113619.6.69. 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**
Name	**UID**	**Name List**	**UID List**		**Negotiation**
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 (Standard Extended object – see 2–4–1–2)	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 2–4–1–3)	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**
Name	**UID**	**Name List**	**UID List**		**Negotiation**
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
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	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 Structure Set

See Section 5 of this document.

The RT Structure Set SOP Instances created by Advantage Sim contain one additional element defined in the Structure Set Module (see Section 5–4–5 of this document), and may contain two additional elements defined in the ROI Contour Module (see Section 5–4–5–2 of this document). These attributes are the private attributes Build Resolution (0249,xx1C), Contour Number (0249,xxC8), and Attached Contours (0249,xxC9). Contour Number and Attached Contours will be replaced by equivalent standard attributes following the adoption of DICOM Change Proposal CP–133. These attributes are provided for enhanced functionality when reading RT Structure Sets created by the Advantage Sim application itself. They should be ignored by SCP implementations interpreting these objects. These attributes are not required in RT Structure Sets created by SCU implementations for use in Advantage Sim.

2–4–1–3 Standard Extended SOP Class RT Plan

See Section 6 of this document.

The RT Plan SOP Instances created by Advantage Sim contain five additional elements in the Beam Sequence (300A,00B0) contained within the RT Beams module (see Section 6–4–5–3 of this document). These five attributes are the private attributes Referenced Machine SOP Class UID (0249,xxC0), Referenced Machine SOP Instance UID (0249,xxC1) of the GE Private DICOM Treatment Machine object used for the beam; the beam group private attributes Group Name (0249,xx51) and Group Properties (0249,xx52); and Associated Markers (0249,xxCA), the list of RT Structure Set markers which are related to the current beam. These attributes have no meaning outside the Advantage Sim application, and are provided for enhanced functionality when reading RT Plans created by the Advantage Sim application itself. They should be ignored by SCP implementations interpreting these objects. These attributes are not required in RT Plans created by SCU implementations for use in Advantage Sim.

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. Text fields of objects using other extended character sets will not be displayed correctly in Advantage Sim.

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.

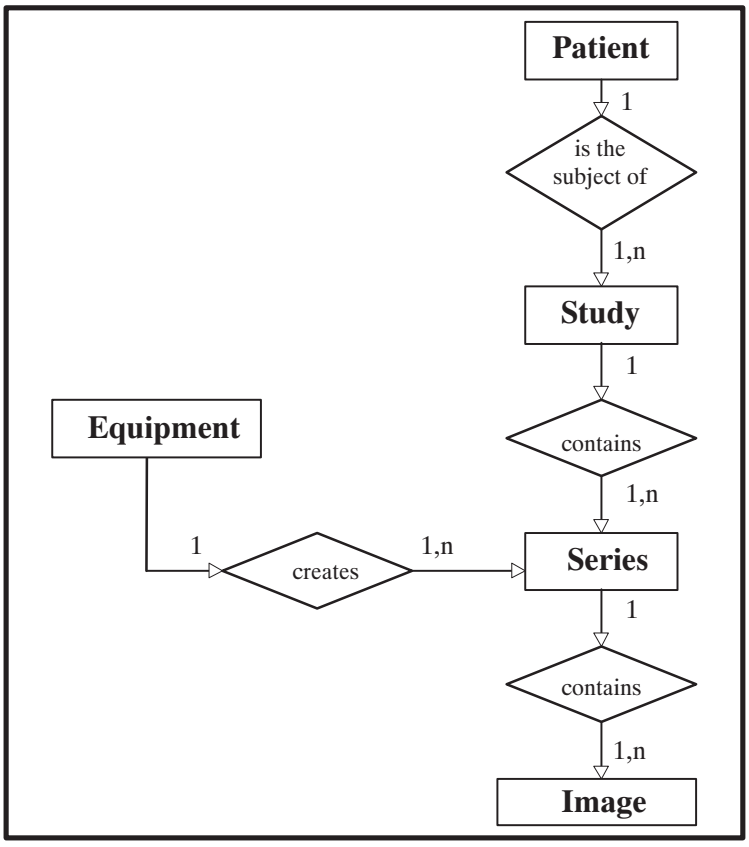
Note that the implementation described in this section relates to generation of SC Images by the Advantage Sim product only. The Advantage Sim application does not display SC Images directly, but relies on the Advantage Workstation product for this function. SC Image conformance for Advantage Workstation 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 (must be present in those images – see Section 8)
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	'4.1.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	'4.1.x'

3–4–5 Image Entity Modules

3–4–5–1 General Image

Attribute Name	Element Tag	TP	Notes
Image (Instance) 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 '1.2.840.113619.2.69'
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	'1.2.840.113619.6.83'

SECTION 4 – RT IMAGE INFORMATION OBJECT IMPLEMENTATION

4–0 Introduction

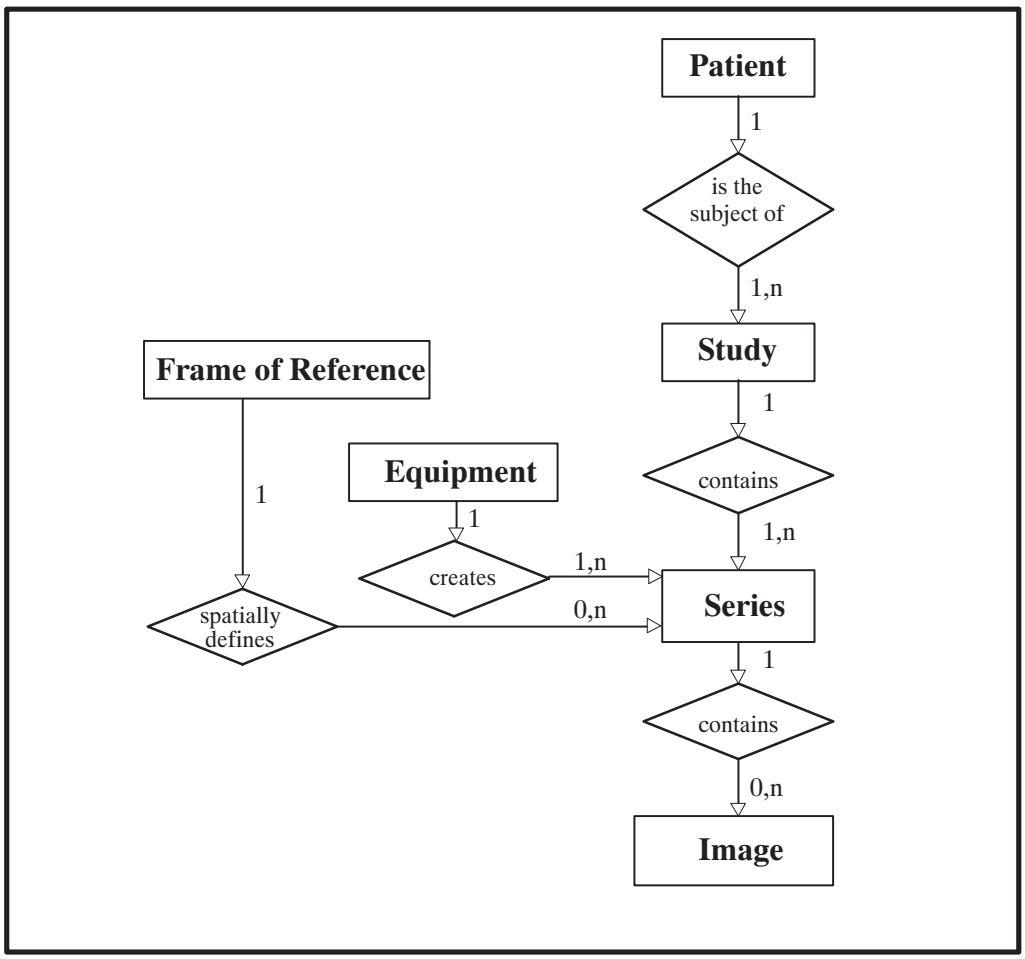
This section specifies the use of the DICOM RT Image IOD to represent the information included in images produced by this implementation. Corresponding attributes are conveyed using the module construct.

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 (must be present in those images – see Section 8)
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	'4.1.x' (single–valued)

4–4–5 Image Entity Modules

4–4–5–1 General Image

Attribute Name	Element Tag	TP	Notes
Image (Instance) 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 ‘1.2.840.113619.2.69’
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	‘1.2.840.113619.6.83’

Blank page.

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

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, and also specifies the requirements for the RT Structure Set IOD when being used as input to Advantage Sim. Corresponding attributes are conveyed using the module construct.

Advantage Sim implements the RT Structure Set IOD as a Standard Extended object, containing six additional elements defined in the Structure Set Module (see Section 5–4–5 of this document). These six attributes are:

- In the Structure Set Module, top level: Build Resolution (0249,xx1C), storing the 3D patient model resolution used in Advantage Sim; Couch Removal Status (0249,xxE0), indicating if the treatment couch had been removed by the Advantage Sim software; View Layout (0249,xxE1), storing the arrangement of views; and Planar View Windowing (0249,xxE2), the display parameters for the 2D non–DRR views.
- In the Structure Set Module, Structure Set ROI Sequence: ROI Generation Thresholds (0249,xxE3) and ROI Bridge Removal Pixels (0249,xxE4), storing the generation parameters for automatically generated structures.

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

Note: This implementation of the RT Structure Set IOD contains the attribute Instance Number (0020,0013), formerly known as Image Number, added to the RT Structure Set object definition in September 1999 (Change Proposals CP–134 and CP–99).

Note: This implementation of the RT Structure Set IOD contains the attributes Contour Number ((3006,0048), VR=IS, VM=1) and Attached Contours ((3006,0049), VR=IS, VM=1–n) added to the RT Structure Set object definition in September 1999 (Change Proposal CP–133). If the receiving implementation fails due to the presence of these attributes (in particular, if its data dictionaries have not been updated), then these attributes can be replaced by equivalent private ones by setting the environment variable AWRT_DICOM_COMPATIBILITY to have a value of “1999” before launching Advantage Sim.

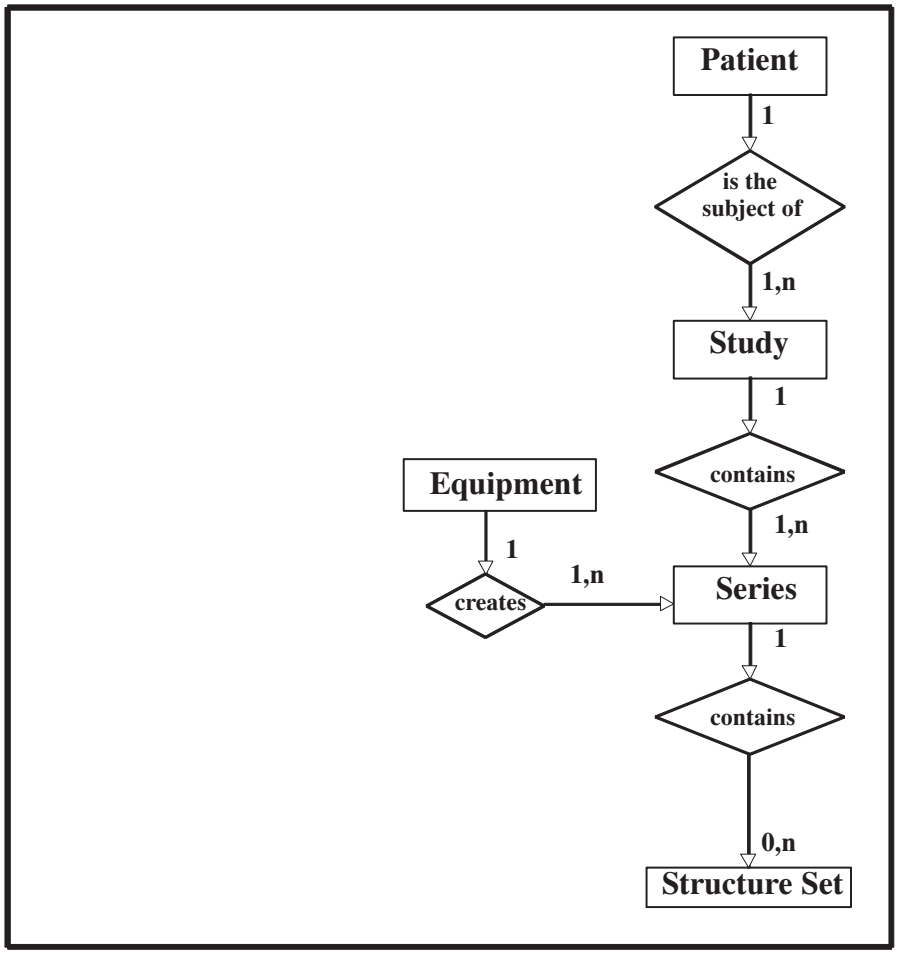
5–1 RT Structure Set IOD Implementation

This section defines the implementation of the RT Structure Set information object in the Advantage Sim application. It refers to the DICOM Standard 1999 Part 3 (Information Object Definitions).

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

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:

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

- each entity is represented by a rectangular boxe.
- 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 1999 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 AUCUN LIEN 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 1999 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 1999 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	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for display and database key. NON–NULL VALUE REQUIRED BY ADV SIM FOR SAFE PATIENT IDENTIFICATION
Patient ID	(0010,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for display and database key. NON–NULL VALUE STRONGLY RECOMMENDED FOR SAFE PATIENT IDENTIFICATION
Patient's Birth Date	(0010,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for database key if non–null. Use of identical value to that found in acquisition images is recommended
Patient's Sex	(0010,0040)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for database key if non–null. Use of identical value to that found in acquisition images is recommended

5–4–2 Study Entity Modules

5–4–2–1 General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	SCU: Duplicated from patient model images SCP: Not used
Study Date	(0008,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Not used
Study Time	(0008,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Not use
Referring Physicians' Name	(0008,0090)	2	SCU: Zero–length SCP: Not used
Study ID	(0020,0010)	2	SCU: Duplicated from patient model images (must be present in those images – see Section 8) SCP: NON–NULL VALUE REQUIRED BY ADV SIM FOR OBJECT IDENTIFICATION
Accession number	(0008,0050)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Not used

5–4–3 Series Entity Modules

5–4–3–1 RT Series

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

5–4–4 Equipment Entity Modules

5–4–4–1 General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	SCU: 'GE MEDICAL SYSTEMS' SCP: Used to determine system creating object and for display, if non–null (recommended for clear identification of creating system)
Station Name	(0008,1010)	3	SCU: <station hostname> SCP: Not used
Manufacturer's Model Name	(0008,1090)	3	SCU: 'Advantage Sim' SCP: Used to determine system creating object and for display, if provided (recommended for clear identification of creating system)
Device Serial Number	(0018,1000)	3	SCU: <station host ID> SCP: Not used
Software Versions	(0018,1020)	3	SCU: '5.0.x' (single–valued) SCP: Used to determine system creating object and for display, if provided (recommended for clear identification of creating system)

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	SCU: Equal to comment entered when saving Advantage Sim Plan, truncated to 16 characters SCP: Used for display and object identification
Structure Set Name	(3006,0004)	3	SCU: Equal to comment entered when saving Advantage Sim Plan (non–truncated) SCP: Used for display and object identification
Instance Number	(0020,0013)	3	SCU: Always provided by Advantage Sim (this attribute has been added to the RT Structure Set object following DICOM Change Proposals CP–99 and CP–134). SCP: Used for display if provided
Structure Set Date	(3006,0008)	2	SCU: Date at moment object was saved SCP: Used for display if non–null
Structure Set Time	(3006,0009)	2	SCU: Time at moment object was saved SCP: Used for display if non–null
Build Resolution (GE private attribute)	(0249,xx1C)	3	SCU: GE private attribute storing resolution of 3D model. Enumerated values: LOW, HIGH. SCP: Used for building 3D model if provided. If not provided, user is prompted for desired build resolution.

Attribute Name	Element Tag	TP	Notes
Couch Removal St (GE private attribute)	(0249,xxE0)	3	SCU: GE private attribute storing whether or not scanner couch has been removed by the Advantage Sim software. Enumerated values: PRESENT, REMOVED. SCP: Used for automatic removal of treatment couch, if present. Not required by Advantage Sim (if absent, user will be asked if treatment couch is to be removed).
View Layout (GE private attribute)	(0249,xxE1)	3	SCU: GE private attribute of four values specifying view types of upper left, upper right, lower left, and lower right Advantage Sim views (in that order). Defined terms: EMPTY = No view 3D = 3D view AXIAL = Axial view SAGITTAL = Sagittal view CORONAL = Coronal view OBLIQUE = Oblique view PROFILE = Profile view CURVED = Curved view SCP: Used to initialize view layout. Not required by Advantage Sim (if absent, default Advantage Sim view layout will be used).
Planar View Windowing (GE private attribute)	(0249,xxE2)	3	SCU: GE private attribute (W, L) specifying window width (centered on window level) and window level in Hounsfield Units for planar Advantage Sim views. SCP: Used to set initial W/L after loading RT Structure Set. Not required by Advantage Sim (if absent, default Advantage Sim W/L will be used).
Referenced Frame of Reference Sequence	(3006,0010)	3	SCU: Sequence will always contain exactly one item, corresponding to the frame of reference of the CT images SCP: MUST CONTAIN ONE OR MORE ITEMS, EXACTLY ONE OF WHICH MUST BE REFERENCED BY ALL ROIS
>Frame of Reference UID	(0020,0052)	1C	SCU: Duplicated from patient model images if present in those images, otherwise a unique UID will be created by Advantage Sim SCP: FOR THE ITEM REFERENCED BY ROIS, MUST CORRESPOND TO FRAME OF REFERENCE UID (0020,0052) OF ACQUISITION IMAGES

Attribute Name	Element Tag	TP	Notes
>RT Referenced Study Sequence	(3006,0012)	3	SCU: Sequence will always contain exactly one item, corresponding to the Study containing the CT images SCP: MUST CONTAIN ONE OR MORE ITEMS, EXACTLY ONE OF WHICH MUST BE REFERENCED BY ROIS
>>Referenced SOP Class UID	(0008,1150)	1C	SCU: Always provided SCP: Not used
>>Referenced SOP Instance UID	(0008,1155)	1C	SCU: Always provided SCP: Not used
>>RT Referenced Series Sequence	(3006,0014)	1C	SCU: Sequence will always contain exactly one item, corresponding to the Series containing the CT images SCP: FOR THE ITEM REFERENCED BY ROIS, MUST CORRESPOND TO CT IMAGE SERIES
>>>Series Instance UID	(0020,000E)	1C	SCU: Always provided SCP: Not used
>>>Contour Image Sequence	(3006,0016)	1C	SCU: Sequence will contain all images used in building the Advantage Sim patient model, even if some images have no corresponding contour SCP: For the RT Referenced Series Sequence item referenced by ROIs, all images will be used to construct 3D model, even if they do not contain a contour. AT LEAST FIVE IMAGE ITEMS MUST BE PROVIDED. SPACING BETWEEN IMAGES IS STRONGLY RECOMMENDED TO BE LESS THAN 10 MM FOR ADEQUATE 3D MODEL RECONSTRUCTION
>>>>Referenced SOP Class UID	(0008,1150)	1C	SCU: Always equal to CT Image SOP Class SCP: Must be equal to CT Image SOP Class
>>>>Referenced SOP Instance UID	(0008,1155)	1C	SCU: Always provided SCP: Required by Advantage Sim to locate referenced images in AW database
Structure Set ROI Sequence	(3006,0020)	3	SCU: Always provided unless there have been no structures defined in Advantage Sim, in which case the sequence will be absent SCP: There is no practical limit to the number of structures in Advantage Sim. This sequence may also be empty (no structures defined).
>ROI Number	(3006,0022)	1C	SCU: Advantage Sim will number structures in increasing numeric order, starting from 1, as they are found in the plan SCP: Used to uniquely identify ROI when referenced by ROI Contour and RT ROI Observations Modules (DICOM requirement). Used to uniquely identify Advantage Sim structures and markers if ROI Name is invalid or not supplied

Attribute Name	Element Tag	TP	Notes
>Referenced Frame of Reference UID	(3006,0024)	1C	SCU: Equal to Frame of Reference UID (0020,0052) above SCP: MUST BE EQUAL TO EXACTLY ONE FRAME OF REFERENCE UID (0020,0052) IN REFERENCED FRAME OF REFERENCE SEQUENCE (3006,0010). ALL ROIS MUST REFERENCE THE SAME FRAME OF REFERENCE
>ROI Name	(3006,0026)	2C	SCU: Equal to Advantage Sim structure name SCP: Used for Advantage Sim structure or marker name if a valid non–duplicate name, otherwise ROI Number is used to uniquely identify ROI in Advantage Sim
>ROI Generation Algorithm	(3006,0036)	2C	SCU: Zero–length SCP: Not used
>ROI Generation Thresholds (GE private attribute)	(0249,xxE3)	3	SCU: GE private attribute (H_l,H_u) representing lower and upper Hounsfield Number thresholds used for automatic contouring of this structure. Attribute will be absent if structure was not contoured automatically. SCP: Used to set default structure contouring thresholds for this structure. Not required by Advantage Sim (if absent, default thresholds will be used).
>ROI Bridge Removal Pixels (GE private attribute)	(0249,xxE4)	3	SCU: GE private attribute representing size in pixels of bridges to be removed during automatic contouring. Attribute will be absent if structure was not contoured automatically. Value of zero indicates remove bridges option was not used. SCP: Used to set default structure remove bridges value for this structure. Not required by Advantage Sim (if absent, no bridge removal will be assumed).

5–4–5–2 ROI Contour

Attribute Name	Element Tag	TP	Notes
ROI Contour Sequence	(3006,0039)	1	SCU: Sequence will always contain all the structures defined in the Structure Set Module, in the same sequential order SCP: Multiple contours on slices (bifurcation or multi–part structures), and slices without contours are permitted. Each item corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020). If none of the structures in the RT Structure Set have defined contours, then ROI Contour Sequence (3006,0039) is zero–length
>Referenced ROI Number	(3006,0084)	1	SCU: Always provided SCP: Must correspond to exactly one ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) (DICOM requirement)

Attribute Name	Element Tag	TP	Notes
>ROI Display Color	(3006,002A)	3	SCU: Contains RGB values corresponding to color used for displaying contour in Advantage Sim application SCP: If RGB values correspond to Advantage Sim color, Advantage Sim color is used. Advantage Sim color triplet RGB values are: Red : 255 0 0 Blue : 0 0 255 Green : 0 255 0 Yellow : 255 255 0 Violet : 155 48 255 Pink : 255 192 203 Lavender : 230 230 250 Orange : 255 165 0 Forest : 34 139 34 YellowGreen : 154 205 50 Khaki : 240 230 140 Aquamarine : 127 255 212 Brown : 165 42 42 SkyBlue : 135 206 235 SlateBlue : 106 90 205 Grey 190 : 190 190 SteelBlue : 70 130 180 Olive : 192 255 62 Tomato: 255 99 71 Otherwise, “nearest” Advantage Sim color is used.
>Contour Sequence	(3006,0040)	3	SCU: Provided if ROI has contours which have been defined by Advantage Sim, otherwise sequence will not be transmitted SCP: Sequence may be absent if no contours have been defined
>>Contour Number	(3006,0048)	3	SCU: Always provided (this attribute has been added to the RT Structure Set object following DICOM Change Proposal CP–133). SCP: WARNING: Bifurcated or multi–part structures without connectivity information may require editing after loading into Advantage Sim.
>>Attached Contours	(3006,0049)	3	SCU: Always provided (this attribute has been added to the RT Structure Set object following DICOM Change Proposal CP–133). SCP: WARNING: Bifurcated or multi–part structures without connectivity information may require editing after loading into Advantage Sim.

Attribute Name	Element Tag	TP	Notes
>>Contour Image Sequence	(3006,0016)	3	SCU: Sequence will always contain exactly one item (referenced CT image) SCP: Contours without a Contour Image Sequence (3006,0016) (i.e. not attached to an acquisition slice) are not used by Advantage Sim
>>>Referenced SOP Class UID	(0008,1150)	1C	SCU: Always provided SCP: Not used
>>>Referenced SOP Instance UID	(0008,1155)	1C	SCU: Always provided SCP: Used to locate acquisition image in order to verify consistency of contour z coordinates.
>>Contour Geometric Type	(3006,0042)	1C	SCU: 'CLOSED_PLANAR' for structures, 'POINT' for markers SCP: Structures with contours other than 'CLOSED_PLANAR' and markers other than 'POINT' will not be used by Advantage Sim
>>Contour Slab Thickness	(3006,0044)	3	SCU: For structures, equal to the sum of the zplus and zminus half thicknesses in Advantage Sim. Not provided for markers SCP: Not used (slab thickness calculated from acquisition slice)
>>Number of Contour Points	(3006,0046)	1C	SCU: In Advantage Sim there is no limit imposed on the number of points in a contour shape SCP: 'CLOSED_PLANAR' CONTOURS MUST HAVE THREE OR MORE POINTS
>>Contour Data	(3006,0050)	1C	SCU: 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. SCP: Contour is projected onto voxel plane of Advantage Sim 3D model which is closest to the Contour Data Z coordinates. THESE Z COORDINATES MUST LIE WITHIN THE SLICE THICKNESS OF THE ACQUISITION SLICE REFERENCED IN THE CONTOUR IMAGE SEQUENCE (3006,0016)

5–4–5–3 RT ROI Observations

Attribute Name	Element Tag	TP	Notes
RT ROI Observations Sequence	(3006,0080)	1	SCU: Sequence will always contain all the structures defined in the Structure Set Module, in the same sequential order SCP: Each item corresponds to an ROI defined in the Structure Set ROI Sequence (3006,0020). If none of the structures in the RT Structure Set have defined contours, then RT ROI Observations Sequence (3006,0080) is zero–length
>Observation Number	(3006,0082)	1	SCU: Advantage Sim will number observations in increasing numeric order, starting from 1 (i.e. Observation Number will correspond to ROI Number) SCP: Not used
>Referenced ROI Number	(3006,0084)	1	SCU: Always provided SCP: Must correspond to exactly one ROI Number (3006,0022) in Structure Set ROI Sequence (3006,0020) (DICOM requirement)
>ROI Observation Label	(3006,0085)	3	SCU: Equal to Advantage Sim structure name, truncated to 16 characters SCP: Not used
>RT ROI Interpreted Type	(3006,00A4)	2	SCU: Supported types are EXTERNAL, PTV, CTV, GTV, AVOIDANCE, ORGAN, CONTRAST_AGENT, CAVITY, and MARKER. Will be zero–length if Structure Type is UNKNOWN in Advantage Sim SCP: ROIs with an Interpreted Type of ISOCENTER will be converted to MARKER. ROIs with an Interpreted Type other than ISOCENTER or those in the above list will be converted to UNKNOWN
>ROI Interpreter	(3006, 00A6)	2	SCU: Zero–length SCP: Not used

5–4–5–4 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	SCU: '1.2.840.10008.5.1.4.1.1.481.3' SCP: Must be equal to '1.2.840.10008.5.1.4.1.1.481.3' (DICOM requirement)
SOP Instance UID	(0008,0018)	1	SCU: UID root will be '1.2.840.113619.2.69' SCP: Used to verify association with RT Plans
Specific Character Set	(0008,0005)	1C	SCU: 'ISO_IR 100' SCP: Specific Character Sets other than 'ISO_IR 100' are not handled explicitly by Advantage Sim
Instance Creation Date	(0008,0012)	3	SCU: Same as Structure Set Date (3006,0008) SCP: Not used
Instance Creation Time	(0008,0013)	3	SCU: Same as Structure Set Time (3006,0009) SCP: Not used
Instance Creator UID	(0008,0014)	3	SCU: '1.2.840.113619.6.83' SCP: If Instance Creator UID corresponds to a version of Advantage Sim, then it is used to prevent loading of old–format RT Structure Sets, otherwise not used

5–5 Private Data Dictionary for RT Structure Set

Private Creator Identification GEMS_RTEN_01

Attribute Name	Element Tag	VR	VM
Build Resolution	(0249,1C)	CS	1
Build Resolution	(0249,1C)	CS	1
GE Contour Number (see Section 5–0)	(0249,C8)	IS	1
GE Attached Contours (see Section 5–0)	(0249,C9)	IS	1–n
Couch Removal Status	(0249,E0)	CS	1
View Layout	(0249,E1)	CS	4
Planar View Windowing	(0249,E2)	IS	2
ROI Generation Thresholds	(0249,E3)	IS	2
ROI Bridge Removal Pixels	(0249,E4)	IS	1

Blank page.

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

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, and also specifies the requirements for the RT Plan IOD when being used as input to Advantage Sim. Corresponding attributes are conveyed using the module construct.

Advantage Sim implements the RT Plan IOD as a Standard Extended object, containing four additional elements defined in the RT General Plan Module (see Section 6–4–5–1), one additional element in the RT Patient Setup Module (see Section 6–4–5–2), and six additional elements in the RT Beams module (see Section 6–4–5–3). These eleven attributes are:

- In the RT General Plan Module: DRR Preset List (0249,xxF0) and Macro List (0249,xxF1), storing lists of presets and macros used in the Advantage Sim application; Print Preferences (0249,xxF3), storing the default settings for the Advantage Sim print function; and Treatment Device Conventions (0249,xxF4), storing the conventions (IEC–1217 or machine–based) used when displaying beam angles and collimator jaws.

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

- In the RT Beams Module: Referenced Machine SOP Class UID (0249,xxC0), and Referenced Machine SOP Instance UID (0249,xxC1) of the GE Private DICOM Treatment Machine object used for the beam; Group Name (0249,xx51) and Group Properties (0249,xx52), properties of the Advantage Sim beam group; Associated Markers (0249,xxCA), the list of RT Structure Set markers which are related to the current beam; and Beam Limiting Device Mode (0249,xxF5), the operating mode of the collimator for the current beam.

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

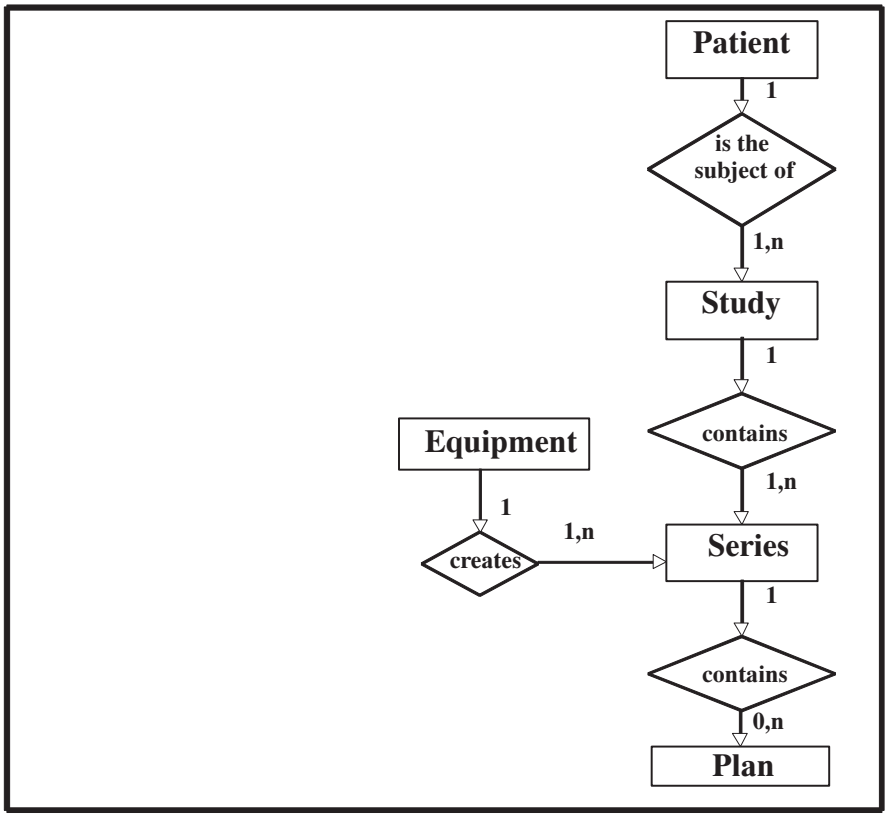
6–1 RT Plan IOD Implementation

This section defines the implementation of the RT Plan information object in the Advantage Sim application. It refers to the DICOM Standard 1999 Part 3 (Information Object Definitions).

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

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 AUCUN LIEN . 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 1999 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 1999 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	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for display and database key. NON–NULL VALUE REQUIRED BY ADV SIM FOR SAFE PATIENT IDENTIFICATION
Patient ID	(0010,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for display and database key. NON–NULL VALUE STRONGLY RECOMMENDED FOR SAFE PATIENT IDENTIFICATION
Patient's Birth Date	(0010,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for database key if non–null. Use of identical value to that found in acquisition images is recommended
Patient's Sex	(0010,0040)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Used for database key if non–null. Use of identical value to that found in acquisition images is recommended

6–4–2 Study Entity Modules

6–4–2–1 General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	SCU: Duplicated from patient model images SCP: Not used
Study Date	(0008,0020)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Not used
Study Time	(0008,0030)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Not used
Referring Physicians' Name	(0008,0090)	2	SCU: Zero–length SCP: Not used
Study ID	(0020,0010)	2	SCU: Duplicated from patient model images (must be present in those images – see Section 8) SCP: NON–NULL VALUE REQUIRED BY ADV SIM FOR OBJECT IDENTIFICATION
Accession number	(0008,0050)	2	SCU: Duplicated from patient model images if present in those images, otherwise zero–length SCP: Not used

6–4–3 Series Entity Modules

6–4–3–1 RT Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	SCU: 'RTPLAN' SCP: Must be 'RTPLAN' (DICOM requirement)
Series Instance UID	(0020,000E)	1	SCU: Created for first image in series, otherwise copied from existing images in series SCP: Not used
Series Number	(0020,0011)	2	SCU: Always provided SCP: Used for display if non–null
Series Description	(0008,103E)	3	SCU: 'Adv Sim RT Plans' SCP: Used for display if provided

6–4–4 Equipment Entity Modules

6–4–4–1 General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	SCU: 'GE MEDICAL SYSTEMS' SCP: Used to determine system creating object and for display, if non–null (recommended for clear identification of creating system)
Station Name	(0008,1010)	3	SCU: <station hostname> SCP: Not used
Manufacturer's Model Name	(0008,1090)	3	SCU: 'Advantage Sim' SCP: Used to determine system creating object and for display, if non–null (recommended for clear identification of creating system)
Device Serial Number	(0018,1000)	3	SCU: <station host ID> SCP: Not used
Software Versions	(0018,1020)	3	SCU: '4.1.x' (single–valued) SCP: Used to determine system creating object and for display, if non–null (recommended for clear identification of creating system)

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	SCU: Equal to comment entered when saving Advantage Sim Plan, truncated to 16 characters SCP: Used for display and object identification
RT Plan Name	(300A,0003)	3	SCU: Equal to comment entered when saving Advantage Sim Plan (non–truncated) SCP: Used for display and object identification
Instance Number	(0020,0013)	3	SCU: Always provided by Advantage Sim (this attribute has been added to the RT Plan object following DICOM Change Proposals CP–99 and CP–134) SCP: Used for display if provided
Operators' Name	(0008,1070)	2	SCU: Equal to operator name entered when saving Advantage Sim Plan SCP: Used for display if non–null
RT Plan Date	(300A,0006)	2	SCU: Date at moment object was saved SCP: Used for display if non–null
RT Plan Time	(300A,0007)	2	SCU: Time at moment object was saved SCP: Used for display if non–null

Attribute Name	Element Tag	TP	Notes
RT Plan Geometry	(300A,000C)	1	SCU: 'PATIENT' SCP: MUST BE 'PATIENT'
Referenced Structure Set Sequence	(300C,0060)	1C	SCU: Sequence will always contain exactly one item, referencing RT Structure Set saved at same time as Plan SCP: ADVANTAGE SIM REQUIRES AN RT STRUCTURE SET BASED ON CT DATA
>Referenced SOP Class UID	(0008,1150)	1C	SCU: '1.2.840.10008.5.1.4.1.1.481.3' (RT Structure Set) SCP: Must be '1.2.840.10008.5.1.4.1.1.481.3' (RT Structure Set)
>Referenced SOP Instance UID	(0008,1155)	1C	SCU: References RT Structure Set instance associated with current plan. In Advantage Sim RT Structure Set and RT Plan instances are always saved as a pair (even when there are no beams defined) SCP: MUST SPECIFY RT STRUCTURE SET UPON WHICH RT PLAN IS BASED
DRR Preset List (GE private attribute)	(0249,xxF0)	3	SCU: GE private attribute storing lists of preset DRR parameters that will be available in the Advantage Sim application when adjusting DRR images. SCP: Not required by Advantage Sim. If present, used to display DRR preset list. Should not be provided by non–GE implementations.
Macro List (GE private attribute)	(0249,xxF1)	3	SCU: GE private attribute storing list of macros that will be available in the Advantage Sim application. SCP: Not required by Advantage Sim. If present, used to initialize macro list. Should not be provided by non–GE implementations.
Print Preferences (GE private attribute)	(0249,xxF3)	3	SCU: GE private attribute storing preferences (defaults) when printing from the Advantage Sim application. SCP: Not required by Advantage Sim. If present, used to initialize printing function. Should not be provided by non–GE implementations.
Treatment Device Conventions (GE private attribute)	(0249,xxF4)	3	SCU: GE private attribute storing default treatment angle and collimator conventions when plan is loaded into Advantage Sim. Enumerated values: IEC1217 = IEC–1217 conventions MACHINE = Machine–specific conventions SCP: Not required by Advantage Sim. If present, used to initialize default treatment conventions.

6–4–5–2 RT Patient Setup

Attribute Name	Element Tag	TP	Notes
Patient Setup Sequence	(300A,0180)	1	SCU: Sequence will always contain exactly one item SCP: Sequence may contain one or more items. ALL BEAMS IN BEAM SEQUENCE (300A,00B0) MUST REFERENCE THE SAME PATIENT SETUP NUMBER (300A,0182).
>Patient Setup Number	(300A,0182)	1	SCU: 1 SCP: Used to uniquely identify Patient Setup referenced by beams.
>Patient Position	(0018,5100)	1C	SCU: Patient treatment position in 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. SCP: NON–NULL VALUE REQUIRED. PATIENT POSITION MUST BE THE SAME AS PATIENT POSITION DEFINED IN CT IMAGES, EXCEPT THAT 'HFS' IS ALSO PERMITTED FOR 'FFS' CT IMAGES, AND 'HFP' IS PERMITTED FOR 'FFP' CT IMAGES. IF CT IMAGE PATIENT POSITION IS NOT DEFINED (DEFAULTS TO 'HFS'), PATIENT POSITION MUST BE 'HFS' HERE.
>Patient Scanned Position (GE private attribute)	(0249, xxF2)	3	SCU: GE private attribute specifying position in which patient was scanned. Strictly equal to value of attribute Patient Position (0018, 5100) in referenced acquisition images. Provided to allow applications reading RT Plan only to correctly transform patient into room coordinate system. This attribute may eventually be replaced by a standard attribute defined in a DICOM Change Proposal. SCP: Not required by Advantage Sim. If present, verified as being same as value of Patient Position (0018, 5100) in referenced acquisition images.

6–4–5–3 RT Beams

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

Attribute Name	Element Tag	TP	Notes
>Referenced Machine SOP Class UID (GE private attribute)	(0249,xxC0)	3	SCU: GE private attribute storing private (GE) SOP Class of treatment machine used to define current beam. Equal to '1.2.840.113619.4.5.251'. SCP: Used for uniquely determining Advantage Sim treatment machine associated with current beam. If this attribute is absent, Treatment Machine Name is used for this purpose.
>Referenced Machine SOP Instance UID (GE private attribute)	(0249,xxC1)	3	SCU: GE private attribute storing SOP Instance of treatment machine used to define current beam. SCP: Used for uniquely determining Advantage Sim treatment machine associated with current beam. If this attribute is absent, Treatment Machine Name is used for this purpose.
>Group Name (GE private attribute)	(0249,xx51)	3	SCU: GE private attribute storing name of Advantage Sim beam group containing current beam. SCP: Used for grouping beams if provided, otherwise placed in a default Advantage Sim beam group, having properties of isocenters unlinked and not equal angles.
>Group Properties (GE private attribute)	(0249,xx52)	3	SCU: GE private attribute storing properties of Advantage Sim beam group containing current beam. Defined Terms: COMM_ISOCENTER = isocenters linked EQUAL_ANGLES = beam gantry angles evenly distributed SCP: Used for grouping beams if provided, otherwise placed in a default Advantage Sim beam group. IF DEFINED, PROPERTIES MUST BE THE SAME FOR ALL BEAMS IN THE GROUP.
>Associated Markers (GE private attribute)	(0249,xxCA)	3	SCU: GE private attribute storing ROI Names (3006,0026) of markers in the associated RT Structure Set which have been defined as relating to the current beam. SCP: Used for associating markers with beams if provided, otherwise all markers are defined as normal (non–associated) markers.
>Source–Axis Distance	(300A,00B4)	3	SCU: Source–axis distance of machine associated with beam in Advantage Sim SCP: MUST BE DEFINED, AND EQUAL TO SOURCE–AXIS DISTANCE SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE. The requirement that this attribute be defined has been imposed to provide a check on the coherence of the critical SAD parameter.

Attribute Name	Element Tag	TP	Notes
>Beam Limiting Device Sequence	(300A,00B6)	1	SCU: Sequence will always contain exactly two items SCP, NON–MLC COLLIMATORS: SEQUENCE MUST CONTAIN EXACTLY TWO ITEMS. THE COMBINATION OF THE TWO RT BEAM LIMITING DEVICE TYPES (300A,00B8) MUST CORRESPOND TO THE COLLIMATOR TYPE SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE. SCP, MLC COLLIMATORS: AS FOR NON–MLC COLLIMATORS, EXCEPT THAT SEQUENCE MAY CONTAIN ADDITIONAL (3^{RD}) SYMMETRIC OR ASYMMETRIC JAW IN SAME DIRECTION AS MULTILEAF JAW. THIS JAW IS IGNORED BY ADVANTAGE SIM. IT MUST NOT FORM PART OF FIELD APERTURE. ADDITIONAL NOTE: ADVANTAGE SIM DOES NOT ACCEPT MLC COLLIMATORS WITH A SYMMETRIC (‘X’ OR ‘Y’) ORTHOGONAL JAW.
>>RT Beam Limiting Device Type	(300A,00B8)	1	SCU: Will be ‘X’, ‘Y’, ‘ASYMX’, ‘ASYMY’, ‘MLCX’ or ‘MLCY’, according to collimator type of machine associated with beam in Advantage Sim SCP: THE TWO ITEMS MUST REPRESENT MUTUALLY ORTHOGONAL JAWS
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	SCU: Will be between 1 and 200 SCP: MUST EQUAL NUMBER OF LEAF/JAW PAIRS SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE
>>Leaf Position Boundaries	(300A,00BE)	2C	SCU: Provided only for ‘MLCX’ and ‘MLCY’ collimators. Advantage Sim supports collimators with unequal leaf widths. SCP: NON–NULL VALUE REQUIRED FOR MLCX OR MLCY COLLIMATORS. MUST EQUAL LEAF POSITION BOUNDARIES SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE.
>>Beam Limiting Device Mode (GE private attribute)	(0249,xxF5)	3	SCU: GE private attribute storing current “mode” of collimator jaw. Defined terms: SYMMETRIC = Functioning as symmetric jaw pair (in the case of MLC’s, all leaves on the same jaw have the same position). ASYMMETRIC = Functioning as asymmetric jaw pair (in the case of MLC’s, all leaves on the same jaw have the same position). MLC = Functioning in full multi–leaf mode. SCP: Used for setting initial collimator mode, if present. Not required by Advantage Sim (if absent, default collimator mode will be used).

Attribute Name	Element Tag	TP	Notes
>Referenced Patient Setup Number	(300C,006A)	3	SCU: 1 (i.e. references only patient setup specified in RT Patient Setup module) SCP: MUST BE DEFINED, and correspond to Patient Setup Number (300A,0182) in exactly one item of Patient Setup Sequence (300A,0180). ALL BEAMS IN BEAM SEQUENCE (300A,00B0) MUST REFERENCE THE SAME PATIENT SETUP NUMBER (300A,0182).
>Treatment Delivery Type	(300A,00CE)	3	SCU: 'TREATMENT' SCP: Not used
>Number of Wedges	(300A,00D0)	1	SCU: 0 SCP: Wedges are ignored by Advantage Sim
>Number of Compensators	(300A,00E0)	1	SCU: 0 SCP: Compensators are ignored by Advantage Sim
>Number of Boli	(300A,00ED)	1	SCU: 0 SCP: Boli are ignored by Advantage Sim
>Number of Blocks	(300A,00F0)	1	SCU: Equal to number of Blocks or Cutouts defined for beam in Advantage Sim SCP: MUST BE ZERO IF RADIATION TYPE (300A,00C6) IS ZERO–LENGTH
>Block Sequence	(300A,00F4)	1C	SCU: Provided if Number of Blocks greater than 0 SCP: Advantage Sim supports both photon blocks and electron blocks (cutouts)
>>Source to Block Tray Distance	(300A,00F6)	2C	SCU: Equal to Source to Block Tray Distance obtained from machine definition of machine associated with beam in Advantage Sim SCP: NON–NULL VALUE REQUIRED. MUST EQUAL SOURCE TO BLOCK TRAY DISTANCE SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE
>>Block Type	(300A,00F8)	1C	SCU: 'SHIELDING' or 'APERTURE'. 'APERTURE' blocks or cutouts are represented by specifying the internal edge only (i.e. keyhole blocks are not explicitly modeled). SCP: Block Type is displayed in Advantage Sim using block or cutout color on BEV
>>Block Divergence	(300A,00FA)	2C	SCU: Zero–length SCP: Not used
>>Block Number	(300A,00FC)	1C	SCU: Blocks will be numbered from 1 to n in order presented in sequence SCP: Used to uniquely identify blocks or cutouts if Block Name is invalid or not supplied

Attribute Name	Element Tag	TP	Notes
>>Block Name	(300A,00FE)	3	SCU: Equal to block name entered in Advantage Sim SCP: Used for Advantage Sim Block or Cutout Name if provided and valid. IF PROVIDED, BLOCK NAME (300A,00FE) MUST BE UNIQUE WITHIN BLOCK SEQUENCE (300A,00F4). If not provided, Block Number (300A,00FC) is used to uniquely identify block or cutout in Advantage Sim
>>Material ID	(300A,00E1)	2C	SCU: Zero–length SCP: Not used
>>Block Thickness	(300A,0100)	2C	SCU: Zero–length SCP: Not used
>>Block Transmission	(300A,0102)	2C	SCU: Zero–length SCP: Not used
>>Block Number of Points	(300A,0104)	2C	SCU: In Advantage Sim there is no software limit imposed on the number of points in a block shape SCP: NON–NULL VALUE REQUIRED. 3 OR MORE POINTS MUST BE PROVIDED
>>Block Data	(300A,0106)	2C	SCU: In Advantage Sim, last data point does not coincide with first beam point (i.e. shape must be closed by connecting first and last point). SCP: NON_NULL VALUE REQUIRED. Last data point is connected to first data point (DICOM specification).
>Final Cumulative Meterset Weight	(300A,010E)	2C	SCU: 100 SCP: Not used
>Number of Control Points	(300A,0110)	1	SCU: 2 (static beam) SCP: MUST BE EQUAL TO 2
>Control Point Sequence	(300A,0111)	1	SCU: Sequence will contain exactly two items. First item will contain all relevant beam parameters. Second element will contain only the attribute Cumulative Meterset Weight (300A,0134), with a value of 100. SCP: SEQUENCE MUST CONTAIN EXACTLY TWO ITEMS. Second control point item is ignored.
>>Control Point Index	(300A,0112)	1C	SCU: 0 for first control point, 1 for second control point SCP: Not used
>>Cumulative Meterset Weight	(300A,0134)	2C	SCU: 0 for first control point, 100 for second control point SCP: Not used

Attribute Name	Element Tag	TP	Notes
>>Nominal Beam Energy	(300A,0114)	3	SCU: Provided for first control point only if beam energy defined in Advantage Sim, otherwise attribute not provided SCP: IF PROVIDED FOR FIRST CONTROL POINT, MUST EQUAL NOMINAL BEAM ENERGY SPECIFIED FOR THE CURRENT BEAM PARTICLE TYPE IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE. Not used for second control point.
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	SCU: Provided for first control point only. Sequence will contain exactly two items. SCP: FOR FIRST CONTROL POINT, SEQUENCE ITEMS RESTRICTED BY CONDITIONS DESCRIBED IN BEAM LIMITING DEVICE SEQUENCE (300A,00B6) ATTRIBUTE DESCRIPTION (SEE ABOVE). Not used for second control point.
>>>RT Beam Limiting Device Type	(300A,00B8)	1C	SCU: Provided for first control point only SCP: For first control point, must correspond to exactly one of Beam Limiting Device Sequence (300A,00B6) items (DICOM requirement). Not used for second control point.
>>>Leaf/Jaw Positions	(300A,011C)	1C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, LEAF/JAW POSITIONS MUST BE WITHIN JAW LIMITS OF CORRESPONDING JAW SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE. Not used for second control point.
>>Gantry Angle	(300A,011E)	1C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, GANTRY ANGLE MUST BE WITHIN GANTRY ANGLE LIMITS SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE. Not used for second control point.
>>Gantry Rotation Direction	(300A,011F)	1C	SCU: Provided (value ‘NONE’) for first control point only SCP: FOR FIRST CONTROL POINT, MUST BE ‘NONE’. Not used for second control point.
>>Beam Limiting Device Angle	(300A,0120)	1C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, BEAM LIMITING DEVICE (COLLIMATOR) ANGLE MUST BE WITHIN COLLIMATOR ANGLE LIMITS SPECIFIED IN CORRESPONDING ADVANTAGE SIM TREATMENT MACHINE. Not used for second control point.

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

Attribute Name	Element Tag	TP	Notes
>>Isocenter Position	(300A,012C)	2C	SCU: Provided for first control point only SCP: FOR FIRST CONTROL POINT, MUST BE PROVIDED. Not used for second control point.
>>Source to Surface Distance	(300A,0130)	3	SCU: Distance from beam origin to first point of patient model encountered along central axis ray. This may not correspond to the true patient surface if the beam passes through the treatment table and the treatment table has not been removed from the patient model. If the central axis ray does not intersect the patient, or intersects through the ends of the patient model, then this attribute will be absent. SCP: Advantage Sim recalculates SSD using isocenter position. If Source to Surface Distance (300A,0130) is provided, and is different from the calculated value, Advantage Sim signals this difference and asks the user if the treatment table needs to be removed from the patient model.

6–4–5–4 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	SCU: '1.2.840.10008.5.1.4.1.1.481.5' SCP: Must be equal to '1.2.840.10008.5.1.4.1.1.481.5' (DICOM requirement)
SOP Instance UID	(0008,0018)	1	SCU: UID root will be '1.2.840.113619.2.69'
Specific Character Set	(0008,0005)	1C	SCU: 'ISO_IR 100' SCP: Specific Character Sets other than 'ISO_IR 100' are not handled explicitly by Advantage Sim
Instance Creation Date	(0008,0012)	3	SCU: Same as Structure Set Date (3006,0008) SCP: Not used
Instance Creation Time	(0008,0013)	3	SCU: Same as Structure Set Time (3006,0009) SCP: Not used
Instance Creator UID	(0008,0014)	3	SCU: '1.2.840.113619.6.83' SCP: Not used

6–5 Private Data Dictionary for RT Plan

Private Creator Identification GEMS_RTEN_01

Attribute Name	Element Tag	VR	VM
Group Name	(0249,51)	SH	1
Group Properties	(0249,52)	CS	1–n
Referenced Machine SOP Class UID	(0249,C0	UI	1
Referenced Machine SOP Instance UID	(0249,C1)	UI	1
Associated Markers	(0249,CA)	SH	1–n
DRR Preset List	(0249,F0)	OB	1
Macro List	(0249,F1)	OB	1
Patient Scanned Position	(0249,F2)	CS	1
Print Preferences	(0249,F3)	OB	1
Treatment Device Conventions	(0249,F4)	CS	1
Beam Limiting Device Mode	(0249,F5)	CS	1

Blank page.

SECTION 7 – GE PRIVATE DICOM RT PLAN INFORMATION OBJECT IMPLEMENTATION

7–0 Introduction

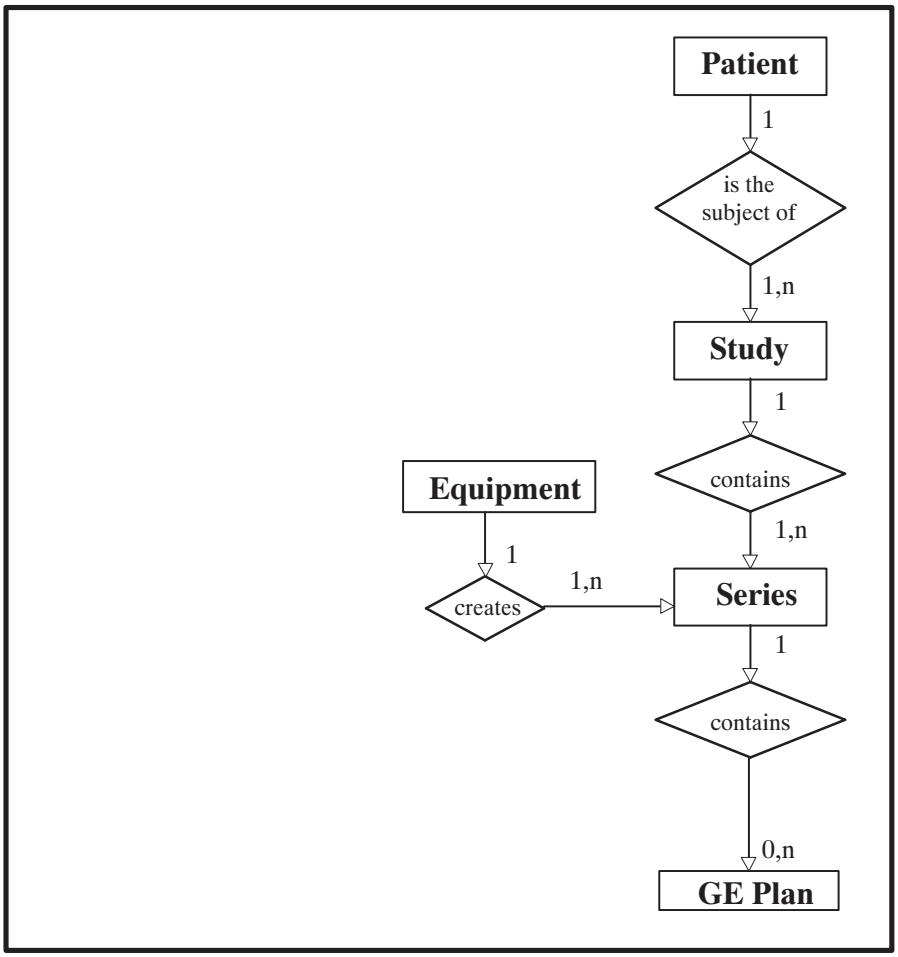
This section specifies the use of the GE Private DICOM RT Plan IOD to represent the information included in plans produced by this implementation. Corresponding attributes are conveyed using the module construct.

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 (must be present in those images – see Section 8). 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	'4.1.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.

Attribute Name	Element Tag	TP	Notes
>>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' (not supported by Advantage Sim).

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.
>Group Properties	(0249,52)	2	Beam Group properties. Defined terms: EQUAL_ANGLES, COMM_ISOCENTER.

Attribute Name	Element Tag	TP	Notes
>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 '1.2.840.113619.2.69'
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	1–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

Blank page.

SECTION 8 – CT IMAGE INFORMATION OBJECT REQUIREMENTS

8–0 Introduction

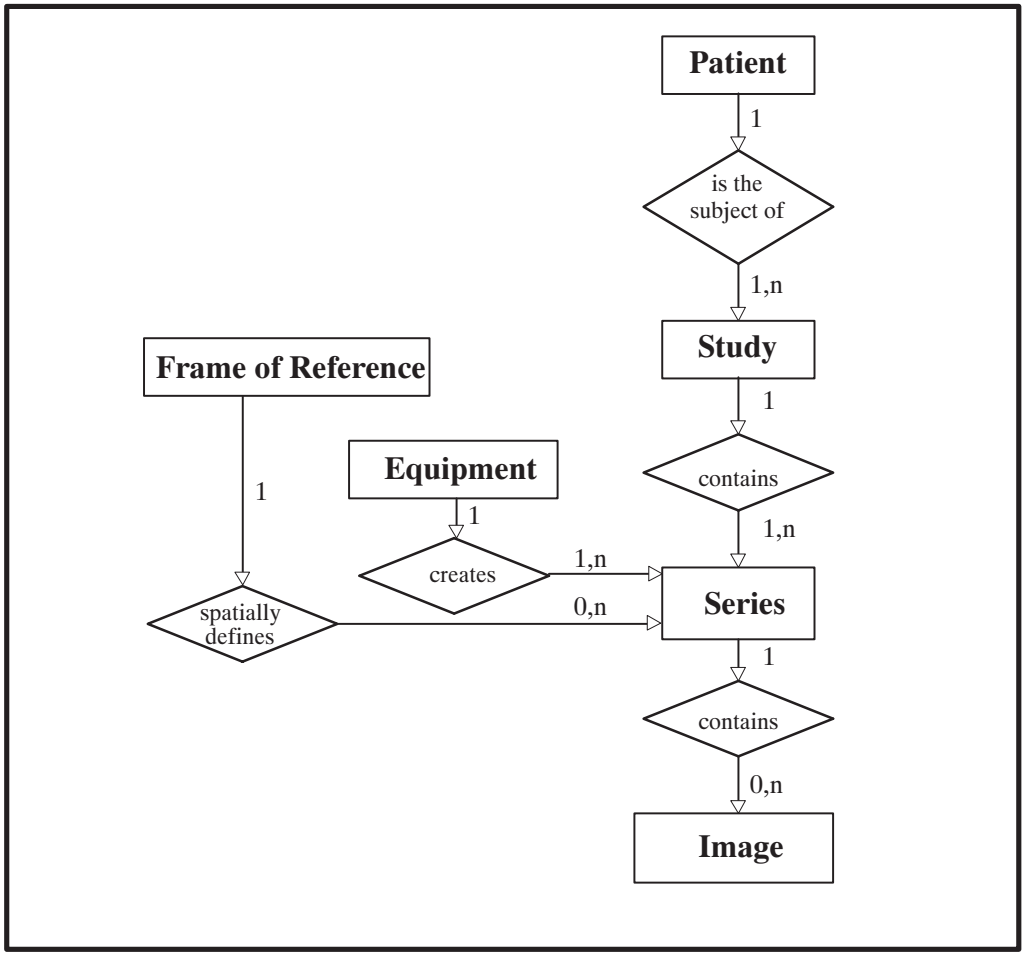
This section specifies the requirements for the DICOM CT Image IOD when being used as input to Advantage Sim.

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.