GE Medical Systems

Technical Publications

Direction 2183325–100

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GENIE Processing & Review System, R1.7 DICOM 3.0 Conformance Statement

Document Structure Information:

The DICOM Print Services for GENIE Processing & Review, R1.7 are defined in a separate document published by ISG Technologies, Inc. The ISG document "Conformance Statement for ISG Hardcopy Server as DICOM Print Management SCU" has been attached to the end of this document with permission.

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REVISION HISTORY

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A–DRAFT	March 9, 1997	(New Document)
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SECTION 0 – Introduction

0–1 OVERVIEW

Section 0, *Introduction*, provides general information about the content and scope of this document.

Section 1, *Implementation Model*, describes the product specific implementation model for the DICOM services provided.

Section 2, *Application Entity Specifications*, defines the DICOM presentation context and association policies implemented in this product.

Section 3, *Communication Profiles*, describes the supported communication stacks.

Section 4, *Extensions, Specializations, Privitizations*, provides information on variances to the DICOM Standard for this product.

Section 5, *Configuration*, describes configuration parameters for this product.

Section 6, *Support of Extended Character Sets*, defines extended character sets supported

Section 7, *GENIE Implementation of the NM IOD*, gives a detailed description of the product specific implementation of the DICOM Nuclear Medicine Multiframe Image Object.

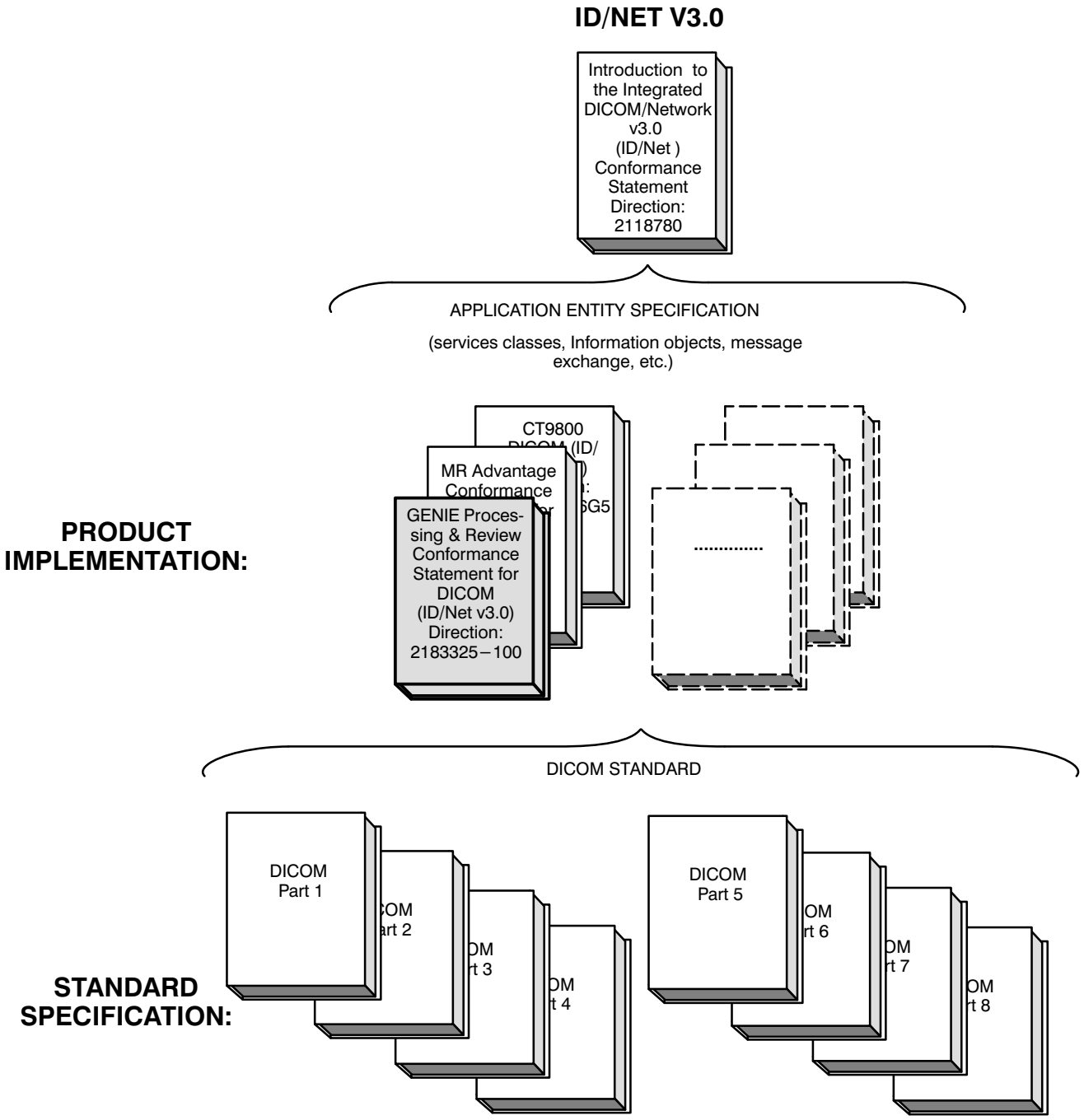
0–2 Overall CONFORMANCE STATEMENT Document Structure

This document describes the DICOM implementation details for the GENIE Processing & Review nuclear medicine imaging system, and contains the formal conformance statement for DICOM compliance.

The structure of this document follows the DICOM Conformance Statement Template defined in Part 2 of *Digital Imaging and Communications in Medicine (DICOM)*, NEMA Standards Publication No. PS 3.2, 1996.

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

ILLUSTRATION 1–1
DOCUMENTATION STRUCTURE



A Conformance Statement for each product documents the DICOM Conformance Statement and Technical Specification required to interoperate with the GEMS ID/Net v3.0 network interface. Introductory information, which is applicable to all GEMS ID/Net 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' ID/Net v3.0 Conformance Statements.

The ID/Net v3.0 Conformance Statement, contained in this document, also specifies the Lower Layer communications which it supports (e.g., TCP/IP). However, the Technical Specifications are defined in the DICOM Part 8 standard.

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

For the convenience of software developers, there is "collector" Direction available. By ordering the collector, the Introduction described above and all of the currently published ID/Net v3.0 Product Conformance Statements will be received. The collector Direction is:

ID/Net v3.0 Conformance Statements
Direction: 2117016

For more information regarding DICOM, copies of the Standard may be obtained by written request or phone by contacting:

NEMA Publications
1300 N 17th Street, Suite 1847
Rosslyn, Virginia 22209 USA
Internet: http://ftp.nema.org/medical/dicom.htm

0–3 INTENDED AUDIENCE

The reader of this document is concerned with software design and/or system integration issues. It is assumed that the reader of this document is familiar with the DICOM 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

In addition, the reader should be familiar with the Nuclear Medicine image modules defined in the DICOM Standard, NEMA Publication PS3.3–1996. This was previously issued by NEMA as *Supplement 7, Nuclear Medicine Image Object.*

0−4 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*, to provide an unambiguous specification for GEMS ID/Net v3.0 implementations. This specification, called a Conformance Statement, includes a DICOM Conformance Statement and is necessary to ensure proper processing and interpretation of GEMS medical image data exchanged using DICOM. The GEMS ID/Net v3.0 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 ID/Net v3.0 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 standard). Unspecified private data element information is subject to change without notice. If, however, the device is acting as a "full fidelity storage device", it should retain and re-transmit all of the private data elements which are sent by GEMS devices.

0−5 IMPORTANT REMARKS

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

- **Interoperability** − The DICOM 3.0 implementation in GENIE R1.7 has been validated for use between GENIE Review and Processing Stations only. Interoperability with any other devices is not supported in this release. It will be the user's responsibility to implement and test any other connectivity options.
- **Integration** − The integration of any device into an overall system of interconnected devices goes beyond the scope of standards (DICOM), 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 are processed or displayed on a GE console or workstation.
- **Future Evolution** − GE understands that the DICOM Standard will evolve to meet the user's growing requirements. GE is actively involved in the development of the DICOM Standard. DICOM will incorporate new features and technologies and GE may follow the evolution of the Standard. ID/Net v3.0 is based on DICOM as specified in each ID/Net DICOM Conformance Statement. Evolution of the Standard may require changes to devices which have implemented DICOM. **In addition, GE reserves the right to discontinue or make changes to the support of communications features (on its products) 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.
- **To be kept informed of the evolution of the implementation described in this document, the User should register on the GE Internet Server, accessible via anonymous ftp, by entering his e−mail address (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 equipment performance and/or function.

0−6 REFERENCES

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

This Conformance Statement refers to the Nuclear Medicine Image Object Definition currently defined in NEMA Standards Publication PS3.3–1996.

0−7 DEFINITIONS

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

0–8 SYMBOLS AND ABBREVIATIONS

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

0–9 PRODUCT NAME NOTATION

This Conformance Statement applies only to Release 1.7 of the GENIE Processing & Review nuclear medicine imaging workstation. The name of the product is sometimes abbreviated to GENIE or GENIE P&R in this document. All of these refer to the processing workstation and not any other product in the GENIE family. GENIE is a trademark of the General Electric Company.

SECTION 1 – Implementation Model

1–1 Introduction

GENIE Processing & Review provides sophisticated image processing and storage functions on nuclear image data acquired through the front end acquisition system. In view of the requirements to conform to a global standard that permits interoperability across equipment produced by different vendors, GENIE will provide support for DICOM 3.0 in several phased-in product releases beginning with R1.7.

This section details the roles and DICOM Service Classes supported by the GENIE P&R product in its version R1.7.

The structure of this section follows the **Conformance Statement Template** as defined in the DICOM V3.0 Standard (Part 2). Please refer to this standard while reading this document.

1–2 Implementation Model Description

As defined in the DICOM Standard V 3.0 two peer DICOM AEs implement a SOP Class of the Storage Service Class with one serving the SCU role and one serving the SCP role. This section describes the conformance requirements of the Storage Service Class in both SCP and the SCU roles.

All DICOM functionality on the GENIE workstation is handled by the CPIPC_DICOM Server Application Entity (AE). The CPIPC_DICOM_Server AE is commanded to perform DICOM services (Storage Service Class) by the user through the buttons and menu selections on the main user interface panel (called the Patient Selector) and the Network Tab Card. The CPIPC_DICOM_Server AE is also listening to a pre–defined port for incoming connections.

1–3 Application Data Flow Diagram

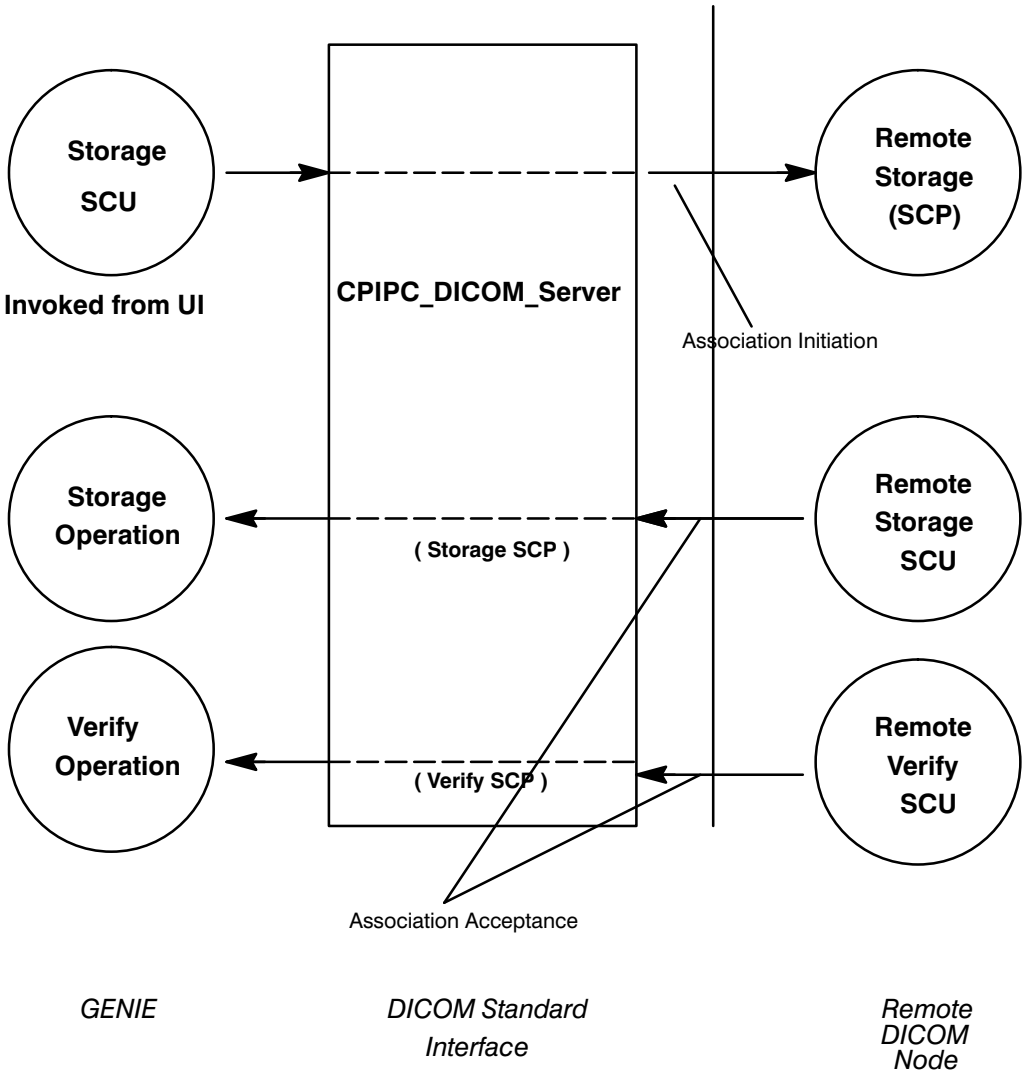
The diagram in the Figure below shows the Storage Service SCU and SCP roles supported on GENIE.

Storage Service Class SCU, Storage Service Class SCP and the Verification Class SCP will be considered to act as a single application entity (as a part of CPIPC_DICOM Server AE for convinience of explanation)

Local real–world activity for Storage SCU service is that of the user invoking the Storage service from the User Interface.

The occurrence of the Local real–world activity is when the remote Storage SCU requests CPIPC_DICOM_Server AE (also referred to as DICOM Server AE) for Image store operation on the GENIE database.

ILLUSTRATION 2–1
SPECIFIC AE APPLICATION MODEL



DICOM Storage Service SCU and SCP Roles supported on GEnie–DICOM

1–4 Functional Definition of AEs

CPIPC_DICOM_Server Application Entity supports the following functions:

- Has access to patient folders and pixel data in the local database
- Initiates a DICOM association to send images to a remote host
- Responds to DICOM associations transmitting images to be stored
- Responds to Verification Requests from remote Verification service class users

1–5 Sequencing of Real–World Activities

Not Applicable

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SECTION 2 – AE Specifications

2–1 GENIE cpipc_dicom_server AE Specifications

Storage Service SCU and **Storage Service SCP** AEs will provide Standard Conformance to the DICOM V 3.0 SOP Classes listed in the Table:

SOP Class Name	SOP Class UID
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20

2–1–1 Association Establishment Policies

Storage Service SCU will attempt only one association at a time. However, multiple copies of the Storage Service SCU may be invoked simultaneously, as a consequence of which the Storage SCU may attempt a number of simultaneous associations limited by GENIE system resource limitations. The Storage SCU can send one or more images on a single association. The number of simultaneous associations which will be accepted by the Storage Service SCP are limited by GENIE system resource limitations.

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

A single DICOM Application Context Name is defined for version 3.0 of the DICOM standard. This name is ”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:

Maximum Length of PDU	**10 Kbytes**

The SOP class Extended Negotiation is not supported.

The maximum number of Presentation Contexts Items that will be proposed is 8. Note that the same Abstract Syntax may be offered multiple times with different Transfer Syntaxes.

2–1–1–2 Number of Associations

The DICOM Server AE will initiate only one DICOM association at a time to perform an image store (SCU) to a remote host.

The DICOM Server AE can however have a maximum of 3 DICOM associations open simultaneously to receive an image store (SCP). This is constrained by GENIE system resource limitations.

Multiple datasets (imagesets) can be sent on a single association from the SCU. These images will be received on the same association by the SCP.

2−1−1−3 Asynchronous Nature

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

2−1−1−4 Implementation Identifying Information

The Implementation UID allows unique identification of a set of products that share the same implementation.

The Implementation UID for this ID/Net v3.0 Implementation is:

GENIE Implementation UID	1.2.840.113619.6.53

2−1−2 Association Initiation Policy

The Storage Service SCU attempts to send multiple images on the same association for each image it attempts to transfer. If a particular image is not sent for whatever reason, then a new association is attempted to send the remaining images. The encoding scheme for transfer will be based on the Presentation Context table for the Storage Service SCU (Table A.2.2). The default encoding scheme will be Big Endian Explicit VR.

2−1−2−1 Real−World Activity − "Send"

The associated real-world activity is the managed using the patient data folder selection and the status windows of the UI. The Storage Service SCU attempts to send multiple images on the same association. If a particular image is not sent for whatever reason, then a new association is attempted to send the remaining images.

2−1−2−1−1 Associated Real−World Activity − Status Notification

Associated real–world activity is notification of the C–STORE operation status on the UI. The UI will indicate the status of the dataset being transferred. The status can be one of ACTIVE, COMPLETED or FAILED. The associated error messages due to a failed status can be one of the following :

- Exceeded the Maximum Job Limit
- Out of System Memory: Cannot Send
- Error in Database Access
- DICOM Configuration Error
- Failed to Connect to DICOM Station

- DICOM Formatting Error
- Failed to disconnect from DICOM Station
- Remote Database Write Error
- Unknown Error returned from Remote Station
- DICOM Protocol Error

and one warning

- Warning!! Dataset does not match SOP Class or Coercion of Data Elements

2−1−2−2 Proposed Presentation Contexts

The proposed Presentation Context Table for the Storage Service SCU is shown in the Table:

Presentation Context Table − Proposed					
Abstract Syntax		Transfer Syntax		Role	Extd. Negot.
Name	UID	Name List	UID List		
NM Image IO	1.2.840.10008.5.1.4.1.1.20	Little Endian Implicit VR	1.2.840.10008.1.2	SCU	None
NM Image IO	1.2.840.10008.5.1.4.1.1.20	Little Endian Explicit VR	1.2.840.10008.1.2.1	SCU	None
NM Image IO	1.2.840.10008.5.1.4.1.1.20	Big Endian Explicit VR	1.2.840.10008.1.2.2	SCU	None

The Storage Service SCU on receiving a confirmation of successful C–STORE operation will lead to normal termination of the association. The current image will be considered successfully stored by the remote SCP. On receiving an Unsuccessful confirmation of the C–STORE operation, the implementation will abort the association.

2−1−2−2−1 SOP Specific Conformance Statement for Image Storage SOP Classes

This implementation can perform multiple C-STORE operations over a single association.

Upon receiving a C-STORE confirmation containing a Successful status, this implementation will perform the next C-STORE operation. The association will be maintained if possible.

Upon receiving a C-STORE confirmation containing a Refused status, this implementation will terminate the association. If there are any more datasets to be sent as a part of the original send request, they will be sent on a different association.

Upon receiving a C-STORE confirmation containing any status that is not Success or Refused, this implementation will consider the current request to be a failure but will continue to attempt to send the remaining images in the request on a different association.

Each C–STORE operation supports a configurable "Association Timer". This timer starts when the association request is sent and stops when the association is established. The default setting is 10000 sec.

Each C–STORE operation also supports a configurable "Session Timer". This timer starts when the association is established and stops when the association is ended. The default setting is 11400 sec.

If any of the above mentioned timers expires, the connection is closed and the operation in progress is considered to be failed.

2−1−3 Association Acceptance Policy

2−1−3−1 Real−World Activity − "Store" Server

The Store SCP is indefinitely listening for associations. No operator action is required to receive an image.The Storage Service SCP after accepting an association , will receive any images transmitted on that association and subsequently store the images in the GENIE database. The associated Real–World Activity associated with the C–STORE operation is the storage of the image data on the disk.

2−1−3−1−1 Associated Real−World Activity

None.

2−1−3−1−2 Accepted Presentation Contexts

The acceptable Presentation Contexts for the Storage Service SCP are shown in Table 2–1:

Presentation Context Table − Accepted					
Abstract Syntax		Transfer Syntax		Role	Extd. Negot.
Name	UID	Name List	UID List		
NM Image IO	1.2.840.10008.5.1.4.1.1.20	Little Endian Implicit VR	1.2.840.10008.1.2	SCP	None
NM Image IO	1.2.840.10008.5.1.4.1.1.20	Little Endian Explicit VR	1.2.840.10008.1.2.1	SCP	None
NM Image IO	1.2.840.10008.5.1.4.1.1.20	Big Endian Explicit VR	1.2.840.10008.1.2.2	SCP	None
Verification	1.2.840.10008.1.1	Little Endian Implicit VR	1.2.840.10008.1.2	SCP	None

TABLE 2–1
PRESENTATION CONTEXTS ACCEPTED

2−1−3−1−2−1 SOP Specific Conformance Statement for Storage SOP Class

The Storage Service SCP will conform to the Storage Service Class at Level 2 (Full). In the event of a successful C–STORE operation, the Image will be successfully stored onto the GENIE database. There are no associated local real–world activities.

(***Note** : Level 2 (Full) — Level 2 conformance indicates that all Type1, Type 2 and Type 3 attributes defined in the Information Object Definition associated with the SOP Class will be stored and may be accessed. The SCP may, but is not required to validate that the attributes of the SOP instance meet the requirements of the IOD.)*

***Application Note:** The GENIE Release 1.7 Storage SCP is designed to accept objects from a GENIE Release 1.7 Storage SCU. Specific implementation details are given in Section 7 of this document. For compatibility with GENIE R1.7 these implementation rules must be supported by other connecting equipment.*

2−1−3−1−2−2 Presentation context acceptance criterion

The criterion for the acceptance of the presentation context will depend on the presentation context table put forward by the remote Storage Service Class SCU. If the presentation context put forward by the remote Storage Service Class SCU is acceptable, (i.e, if one or more presentation contexts are supported by the Storage Service Class SCP) then the presentation context that will be accepted by the SCP, will be the one to which the remote Storage Service Class SCU has accorded the highest priority.

2−1−3−1−2−3 Transfer syntax selection policies

The transfer syntax selected will depend on the presentation context chosen.

2−1−3−2 Real−World Activity − "Verify" Server

The Verification SCP is indefinitely listening for associations. No operator action is required to receive a verification request from a remote Verification SCU. The Verification Service SCP after accepting an association , will inform the remote Verification SCU that the verification request has been accepted and then responds to the request appropriately.

2−1−3−2−1 Associated Real−World Activity − Status Notification

None.

2−1−3−2−2 Accepted Presentation Contexts

The acceptable Presentation Contexts for the Verification Service SCP are shown in Table 2–1.

2−1−3−2−2−1 Presentation context acceptance criterion

The criterion for the acceptance of the presentation context will depend on the presentation context table put forward by the remote Verification Service Class SCU. If the presentation context put forward by the remote Verification Service Class SCU is acceptable, (i.e, if the presentation context is supported by the Verification Service Class SCP) then the association is made.

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SECTION 3 – Communication Profiles

3–1 Supported Communication Stacks (DICOM parts 8,9)

DICOM Upper Layer (Part 8) is supported using TCP/IP.

3–2 OSI Stack

The OSI stack is not applicable to this product.

3–3 TCP/IP Stack

The TCP/IP stack is inherited from a UNIX Operating System. (HP–UX 9.05)

3–3–1 API

Not applicable to this product.

3–3–2 Physical Media Support

Ethernet 802.3 provides the physical network layer for this product.

3–4 Point–to–Point Stack

A 50–pin ACR–NEMA connection (DICOM Part 9) is not applicable to this product.

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SECTION 4 – Extensions/Specializations/Privatizations

4–1 GENIE Extensions / Specializations / Privatizations

The GENIE implementation described in this conformance statement uses extensions to the standard Nuclear Medicine SOP classes in order to transfer GENIE database attributes which are not available in the Nuclear Medicine IOD. These extensions will be defined in a future release of this document in the form of a private data dictionary.

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SECTION 5 – Configuration

5–1 Introduction

The GENIE Processing & Review system is designed to operate in a networked environment with other DICOM compatible equipment. The GENIE P & R system is configured by a GEMS Field Service Engineer as part of the installation process. The parameters described below may be configured or re-configured by a Field Service Engineer, but are not accessible through the system application user interface.

5–2 Configuration

5–2–1 AE Title/Presentation Address Mapping

The following parameters are set by the system installation configuration script:

– AE title is set by default to the hostname changed to upper case
– IP address and hostname are set as determined by site specific network configuration
– Port number is set by default to 2030

5–2–2 Configurable Parameters

The following parameters may be configured for each remote DICOM Server AE :

– Application Entity Title
– Listening TCP/IP Port Number
– Remote IP Address

The above configurations may be subject to restrictions dictated by the GEMS DICOM Access Kit API.

5–2–3 Non-Configurable Parameters

The maximum number of simultaneous associations, association time-outs, buffer sizes, and other asscoiation configuration parameters are defined in system configuration files, but are not intended to be re-configured in the field.

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SECTION 6 – Extended Character Sets

6–1 Support of Extended Character Sets

The GENIE PROCESSING & REVIEW AEs will support only the ISO–IR–100 (ISO 8859–1:1987 Latin alphabet N 1. supplementary set). Any incoming SOP instance that is encoded using another extended character set will not be installed in the local database.

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SECTION 7 – GENIE Implementation of the NM IOD

7–1 Introduction

The GENIE Processing & Review implementation of DICOM conforms to the basic information model and the Nuclear Medicine Information Object defined in the DICOM Standard, NEMA Publication PS3.3–1996 and related documents.

The GENIE P & R implementation of DICOM uses the new Nuclear Medicine multi–frame image format when creating image objects for export, and when importing image data from other systems. All of the DICOM Type 1, Type 2 and Type 3 data elements for NM Images are supported. Most other data elements defined in the NM IOD are also supported. In order to preserve full fidelity when transferring data from one GENIE system to another GENIE system, many specialized database attributes are encoded as private DICOM elements. The private data dictionary is not included in this release of the conformance statement.

7–2 GENIE export of Nuclear Medicine images

The DICOM NM Image Objects created by GENIE R1.7 for each of the standardized nuclear medicine data types make use of the Frame Increment Pointer and indexing vectors with some limitations. In the R1.7 version of the Genie DICOM software a separate NM Image is created for each Detector and each Energy Window when multiple detector and multiple energy data is selected for export from the GENIE database selector. The frame organization and vector usage are illustrated below using examples for each of the Nuclear Medicine Image Types.

7–2–1 Static and Whole Body Images

For Static and Whole Body Images, a separate image is always produced for each additional detector and each additional energy range. Each DICOM Image contains a single frame.

Example: Static Acquisition with 2 Energy Windows and 2 Detectors

In the DICOM exported data, the datasets from each of the 4 Energy Window / Detector combinations will be instantiated as separate Series objects. In each of the 4 NM Images all required vectors contain the value 1.

7–2–2 Dynamic Images

Dynamic datasets are exported using the Phase Vector and Time Slice Vector of the NM Multiframe Image Object. Each DICOM Image may contain one or more related phases of dynamic data. A separate DICOM dynamic Image is always produced for each additional detector and each additional energy range.

Example: Dynamic Acquisition with 3 Phases

This example is for a DYNAMIC acquisition made with:

2 Energy Window Groups
2 Detector Head Groups
3 Dynamic Phases, with:
Ph 1 = 3 Frames
Ph 2 = 10 Frames
Ph 3 = 1 Frame

In the DICOM exported data, the datasets from each of the 4 Energy Window / Detector combinations will be instantiated as separate Series objects. Within each Series the Nuclear Medicine Multiframe construct is used to group the Frames at the lowest level. For this example the required Multiframe Attributes for each Image object are set as follows:

Number of Frames =	14
Energy Window Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Energy Windows =	1
Detector Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Detectors =	1
Phase Vector =	1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 3
Number of Phases =	3
Time Slice Vector =	1, 2, 3, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1

7–2–3 Multigated Images

For Multigated Images, a separate Nuclear Medicine Image is created for each Energy Window, Detector, and R-R Interval Window. Multigated datasets are exported using the Time Slot Vector of the NM Multiframe Image Object.

Example: Multigated Acquisition with 2 R-R Interval Groups

This example is for a GATED acquisition made with:

1 Energy Window Groups
2 Detector Head Groups
2 R-R Window Groups, each with:
16 Time Slots (Frames)

On the GENIE system the images for each Energy Window group, each Detector group, and each RR Interval Group are in separate Datasets. In the DICOM export format each of the 4 Datasets is instantiated as a separate NM Series object. Within each Series the Nuclear Medicine Multiframe construct is used to group the Frames at the lowest level. For this example the required Multiframe Attributes for each Image object would be set as follows:

Number of Frames =	16
Energy Window Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Energy Windows =	1
Detector Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Detectors =	1
R-R Interval Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of R-R Intervals =	1
Time Slot Vector =	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
Number of Time Slots =	16

7–2–4 Tomo Images

For TOMO Images, a separate Nuclear Medicine Image is created for each Energy Window, Detector, and Rotation Group. TOMO datasets are exported using the Angular View Vector of the NM Multiframe Image Object.

Example: TOMO Acquisition with 2 Energy Windows and 2 Detectors

This example is for a TOMO acquisition made with:

2 Energy Window Groups
2 Detector Head Groups
each with:
32 Angular Views (Frames)

In the DICOM exported data, the datasets from each of the 4 Energy Window / Detector combinations will be instantiated as separate Series objects. Within each Series the Nuclear Medicine Multiframe object is used to group the Frames at the lowest level, which for TOMO acquisition is the angular views. For GENIE data there can only be one rotation of the gantry represented in the database, so the Rotation Vector contains a 1 for all frames. For the example shown, the required TOMO Attributes for each Image object would be set as follows:

Number of Frames =	32
Energy Window Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Energy Windows =	1
Detector Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Detectors =	1
Rotation Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Rotations =	1
Angular View Vector =	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ... , 29, 30, 31, 32

7–2–5 Multigated Tomo Images

For MULTIGATED TOMO Images, a separate Nuclear Medicine Image is created for each Energy Window, Detector, R-R Interval Window, and multigated Time Slot. MULTIGATED TOMO datasets are exported using the Angular View Vector of the NM Multiframe Image Object.

Example: Multigated Tomo Acquisition with Multiple Sequencing Attributes

This example is for a MULTIGATED TOMO acquisition made with:

1 Energy Window Group
2 Detector Head Groups
2 R-R Window Groups
each with:
8 Time Slots (per gating interval)
each with:
32 Angular Views (per Time Slot) = 32 Frames

For this example there are $1 \times 2 \times 2 \times 8 = 32$ DICOM Images produced. Each Image represents one time slot in the cardiac cycle in the acquisition sequence. Each of the 32 Images will be instantiated as a separate Series object. Within each Image the Nuclear Medicine Multiframe object definition is used to group the Frames at the lowest level, which for MULTIGATED TOMO acquisition is the angular views. For GENIE data there can only be one rotation of the gantry represented in the database, so the Rotation Vector contains a 1 for all frames.

For this example, the required MULTIGATED TOMO Attributes for each Image object would be set as follows:

Number of Frames =	32
Energy Window Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Energy Windows =	1
Detector Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Detectors =	1
Rotation Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Rotations =	1
R-R Interval Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of R-R Intervals =	1
Time Slot Vector =	1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
Number of Time Slots =	1
Angular View Vector =	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ... , 29, 30, 31, 32

7–2–6 Reconstructed Tomo Images

For RECON TOMO Images, a separate Nuclear Medicine Image is created for each set of slices using the Slice Vector and Number of Slices attribute.

Example: RECON TOMO Image Set with 17 slices

For this example the required Multiframe Attributes for each Image object would be set as follows:

Number of Frames =	17
Slice Vector =	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17
Number of Slices =	17

7–3 GENIE Import of Nuclear Medicine Images

The DICOM NM Image Objects to be imported by GENIE R1.7 must not include multiple Detector and Energy Window sets of frames within a single Image. Each energy window group

and each detector group must be instantiated in a separate NM Image. Other import requirements are given below for each of the Nuclear Medicine Image Types. Increased use of the DICOM Nuclear Medicine frame vectors is planned for future releases of GENIE.

The applicability of imported image data for image processing and review may depend on attributes which are contained in the GENIE private data dictionary, the grouping of datasets within the patient folder structure, naming of related datasets, and other factors. Display of imported images should always be possible if all Type 1, Type 2 and relevant Type 3 attributes are included.

7–3–1 Static and Whole Body Images

Each DICOM Image must contain a single frame.

7–3–2 Dynamic Images

Dynamic datasets are imported using frame attributes contained in Standard and Private attribute elements. The Phase Vector and Time Slice Vector of the NM Multiframe Image Object are not interpreted for imported data. Each DICOM Image may contain 1 to 3 related phases of dynamic data based on private phase attributes.

7–3–3 Multigated Images

Multigated datasets are imported using frame attributes contained in Standard and Private attribute elements. The Time Slot Vector of the NM Multiframe Image Object is not interpreted for imported data.

7–3–4 Tomo Images and Reconstructed Tomo Images

TOMO datasets are imported using frame attributes contained in Standard and Private attribute elements. The Angular View Vector and Slice Vector of the NM Multiframe Image Object are not used to import data. Only 1 Rotation Group is permitted in an Image.

7–3–5 Multigated Tomo Images and Reconstructed Multigated Tomo Images

MULTIGATED TOMO datasets are imported using frame attributes contained in Standard and Private attribute elements. The Angular View Vector and Slice Vector of the NM Multiframe Image Object are not used to import data. All frames in each NM Image must be from the same multigated Time Slot. A separate NM Image in the Series is required for each additional Time Slot.

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Conformance Statement for
ISG Hardcopy Server as DICOM Print Management SCU

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Circulation:

Author	**Darek Tomaszewski**	_____	_____
Program Manager	John Collins *	_____	_____
Platforms Director	Loris Sartor		
Architect DcS, ArS, HcS	Gerrit Visser†		
Project Leader	David Ty†		
Account Manager	Peter Bak		

† *Mandatory reviewers.*

* *The signature of the Program Manager attests that the mandatory reviewers have approved this document.*

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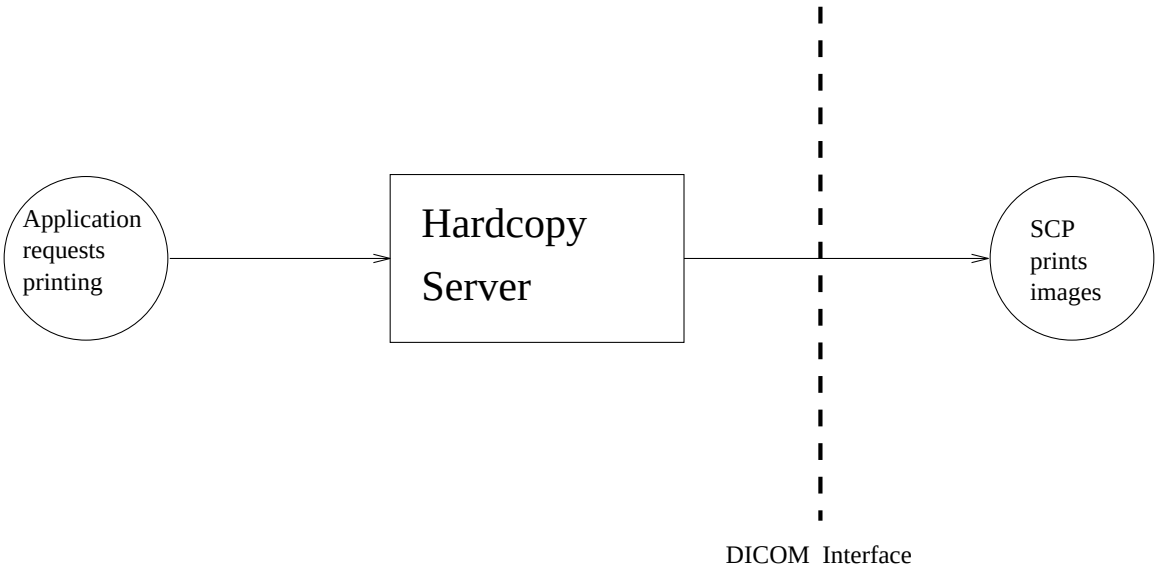
1. Introduction

The ISG Hardcopy Server (*hcserver*) supports printing to DICOM Print Management SCP. The *hcserver* acts as an SCU of the DICOM print management SOP classes. It uses a configuration file for specifying the behaviour specific to different DICOM SCPs.

2. Implementation Model

2.1. Application Data Flow Diagram

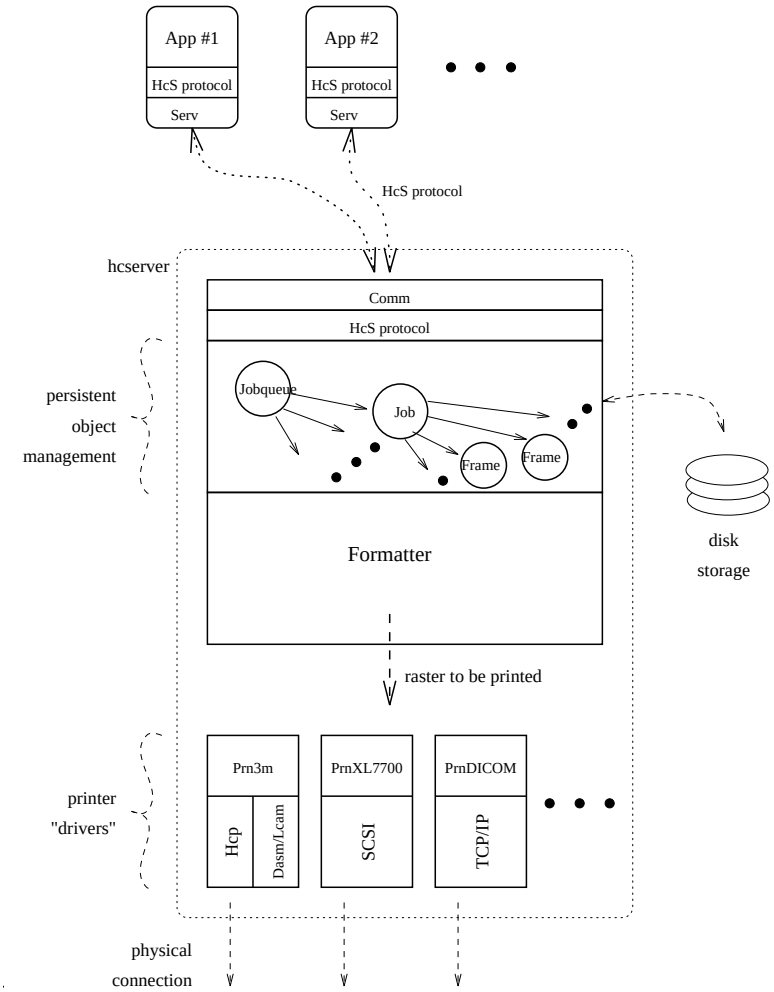
The relationship of the *hcserver* use of DICOM to real world activities is presented in the following diagram.



The application using the Hardcopy Server requests printing to a print device. The Hardcopy Server initiates an association with a DICOM print SCP for the purpose of printing the job requested by the application. The Hardcopy Server can handle simultaneous associations with a number of DICOM print SCPs.

2.2. Functional Definition of Application Entities

The model of the *hcserver* is presented in the following diagram.



Multiple client applications are connected to an instance of the Hardcopy server. Each connection can be made locally, if both the client and the server are executing on the same machine, or remotely, when the client and the server are running on different machines connected via networking.

The Hardcopy server consists of a Comm layer, which handles the communications, and a layer for interpreting the HcS command and data protocol. Commands and data result in various objects being created:

Jobqueue A jobqueue in the model of IAP Hardcopy server consists of several jobs, queued in priority and FIFO order. This permits pre-emptive printing of high priority jobs, if desired.

Job A job is composed of several frames, each of which defines a physical region of a film and the contents thereof. A job has an associated set of formatting commands. which specify such details as film layout, number of copies, choice of printer, and other parameters that pertain to the entire job.

Frame A frame is a set of formatting commands, such as commands to display an image with overlay text and graphics, the location of the image on the film, and other relevant information required for printing images onto films.

When a job appears at the front of a queue, the Formatter will prepare the job prior to sending it to the printer. Image viewing transformations are applied, contrast and brightness adjustment are performed, and text and graphics overlays are added. A formatted image is passed to the appropriate printer driver, which handles the physical link to the printer, the data communication between the host computer and the printer, and the processing of status and error messages from the printer.

For printing to a DICOM print server, a DICOM print SCU driver is provided. Multiple instances of DICOM print SCU driver can co-exist, and each instance handles the association with one DICOM print server.

2.3. Sequencing of Real-World Activities

N/A.

3. Application Entity (AE) Specifications

The *hcserver* represents a single Application Entity. It acts independently of other DICOM applications that may be running on the same system. The *hcserver* can support printing to multiple DICOM printers at the same time, each printer being uniquely identified by an Application Entity Title.

3.1. AE Print User - Specification

The *hcserver* provides Standard Conformance to the following DICOM 3.0 SOP Classes as an SCU:

SOP Class Name	SOP Class UID
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18

3.1.1. Association Establishment Policies

3.1.1.1. General

The *hcserver* maintains a separate association with each DICOM SCP. It releases the association with DICOM SCP if no operation is done on the association in a selected time period.

3.1.1.2. Number of Associations

There is no limit on the number of associations maintained simultaneously with one or different DICOM SCPs.

3.1.1.3. Asynchronous Nature

The *hcserver* does not support asynchronous operations and will not perform asynchronous window negotiation.

3.1.1.4. Implementation Identifying Information

The *hcserver* implementation class UID is 2.16.124.113531.1.3.1, the implementation version name is ISG_HCS_V1.0.96.

3.1.2. Association Initiation Policy

The *hcserver* maintains a list of valid print servers and can present that list to the applications upon request. When the application submits a print job designated for a listed print server to the *hcserver*, the *hcserver* will request an association with the selected print server.

3.1.2.1. Printing encoded with Implicit or Explicit VR

3.1.2.1.1. Associated Real-World Activity

The application's print request causes the *hcserver* to initiate an Association.

3.1.2.1.2. Proposed Presentation Contexts

The *hcserver* will propose one of the presentation contexts listed in the Presentation Context Table.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
Basic GrayScale Print Management	1.2.840.10008 .5.1.1.9	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None
Basic Color Print Management	1.2.840.10008 .5.1.1.18	DICOM Implicit VR Little Endian Transfer Syntax	1.2.840.10008.1.2	SCU	None

3.1.2.1.2.1. SOP Specific Conformance to Basic Grayscale Print Management Meta SOP Class

The *hcserver* supports the following mandatory SOP classes which are defined under the Basic Grayscale Print Management Meta SOP Class:

Name	UID
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.1.4
Printer SOP Class	1.2.840.10008.5.1.1.14

The *hcserver* supports the following optional SOP class attributes and DIMSE services for the Basic Grayscale Print Management Meta SOP Class.

SOP Class	DISME Service	Optional Attribute	Tag
Basic Film Session SOP Class	N-CREATE	Number of Copies	(2000,0010)
		Print Priority	(2000,0020)
		Medium Type	(2000,0030)
		Film Destination	(2000,0040)
		Film Session Label	(2000,0050)
		Memory Allocation	(2000,0060)
Basic Film Box SOP Class	N-CREATE	Film Orientation	(2010,0040)
		Film Size ID	(2010,0050)
		Magnification Type	(2010,0060)
		Max Density	(2010,0130)
		Configuration Information	(2010,0150)
		Smoothing Type	(2010,0080)
		Border Density	(2010,0100)
		Empty Image Density	(2010,0110)
		Min Density	(2010,0120)
		Trim	(2010,0140)
	N-DELETE		
Basic Grayscale Image Box SOP Class	N-SET	Polarity	(2020,0020)
Printer SOP Class	N-GET		

3.1.2.1.2.1.1. Basic Film Session SOP Class (1.2.840.10008.5.1.1.1) attributes

The *hcserver* supports the following mandatory and optional attribute values in this SOP class:

Attribute Name	Tag	Supported values
Number of Copies	(2000,0010)	Integer String
Print Priority	(2000,0020)	HIGH, MED, LOW
Medium Type	(2000,0030)	PAPER, CLEAR FILM, BLUE FILM
Film Destination	(2000,0040)	MAGAZINE, PROCESSOR
Film Session Label	(2000,0050)	Long String
Memory Allocation	(2000,0060)	Integer String

3.1.2.1.2.1.2. Basic Film Box SOP Class (1.2.840.10008.5.1.1.2) attributes

The *hcserver* supports the following mandatory and optional attribute values in this SOP class:

Attribute Name	Tag	Supported values
Image Display Format	(2010,0010)	STANDARD, ROW, COL, SLIDE, SUPERSLIDE, CUSTOM
Film Orientation	(2010,0040)	PORTRAIT, LANDSCAPE
Film Size ID	(2010,0050)	8INX10IN, 10INX14IN, 14INX14IN,24CMX24CM,10INX12IN, 11INX14IN, 14INX17IN, 24CMX30CM
Magnification Type	(2010,0060)	REPLICATE, BILINEAR, CUBIC, NONE
Smoothing Type	(2010,0080)	SCP specific
Border Density	(2010,0100)	BLACK, WHITE, i where i represents the desired density in hundredths of OD
Empty Image Density	(2010,0110)	BLACK, WHITE, i where i represents the desired density in hundredths of OD
Min Density	(2010,0120)	Unsigned Short
Max Density	(2010,0130)	Unsigned Short
Trim	(2010,0140)	YES, NO
Configuration Information	(2010,0150)	SCP specific

3.1.2.1.2.1.3. Basic Grayscale Image Box SOP Class (1.2.840.10008.5.1.1.4) attributes

The *hcserver* supports the following mandatory and optional attributes in this SOP class:

Attribute Name	Tag	Supported values
Image Position	(2020,0010)	Unsigned Short
Polarity	(2020,0020)	NORMAL, REVERSE
Magnification Type	(2010,0060)	REPLICATE, BILINEAR, CUBIC, NONE
Smoothing Type	(2010,0080)	SCP specific
Requested Image Size	(2020,0030)	Unsigned Short
Preformatted Grayscale Image Sequence	(2020,0110)	
>Samples Per Pixel	(0028,0002)	1
>Photometric Interpretation	(0028,0004)	MONOCHROME1, MONOCHROME2
>Rows	(0028,0010)	Unsigned Short
>Columns	(0028,0011)	Unsigned Short
>Pixel Aspect Ratio	(0028,0034)	1:1
>Bits Allocated	(0028,0100)	8
>Bits Stored	(0028,0101)	8
>High Bit	(0028,0102)	7
>Pixel Representation	(0028,0103)	0000H (unsigned integer)
>Pixel Data	(7FE0,0010)	Other Byte String

3.1.2.1.2.1.4. Printer SOP Class (1.2.840.10008.5.1.1.14) attributes

The *hcserver* makes use of the following attributes and attribute values in this SOP class:

Attribute Name	Tag	Supported values
Printer Status	(2110,0010)	NORMAL, WARNING, FAILURE
Printer Status Info	(2110,0020)	SUPPLY EMPTY, SUPPLY LOW, RECEIVER FULL, FILM JAM
Printer Name	(2110,0030)	Long String
Manufacturer	(0008,0070)	Long String
Manufacturer Model Name	(0008,1090)	Long String
Device Serial Number	(0018,1000)	Long String
Software Versions	(0018,1020)	Long String(s)

3.1.2.1.2.2. SOP Specific Conformance to Basic Color Print Management Meta SOP Class

The *hcserver* supports the following mandatory SOP classes which are defined under the Basic Color Print Management Meta SOP Class.

Name	UID
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2
Basic Color Image Box SOP Class	1.2.840.10008.5.1.1.4.1
Printer SOP Class	1.2.840.10008.5.1.1.14

The optional SOP class attributes and DIMSE services for the Basic Film Session,Basic Film Box and Printer SOP classes are listed in the SOP Specific Conformance section for the Basic Grayscale Print Management Meta SOP Class.

The *hcserver* supports the following optional SOP class attributes and DIMSE services for the Basic Color Image Box SOP Class.

SOP Class	DISME Service	Optional Attribute	Tag
Basic Color Image Box SOP Class	N-SET	Polarity	(2020,0020)

3.1.2.1.2.2.1. Basic Color Image Box SOP Class (1.2.840.10008.5.1.1.4.1) attributes

The *hcserver* supports the following attributes in this SOP class:

Image Position	(2020,0010)	Unsigned Short
Polarity	(2020,0020)	NORMAL, REVERSE
Magnification Type	(2010,0060)	REPLICATE, BILINEAR, CUBIC, NONE
Smoothing Type	(2010,0080)	SCP specific
Requested Image Size	(2020,0030)	Unsigned Short
Preformatted Color Image Sequence	(2020,0111)	
>Samples Per Pixel	(0028,0002)	3
>Photometric Interpretation	(0028,0004)	RGB
>Rows	(0028,0010)	Unsigned Short
>Columns	(0028,0011)	Unsigned Short
>Pixel Aspect Ratio	(0028,0034)	1:1
>Bits Allocated	(0028,0100)	8
>Bits Stored	(0028,0101)	8
>High Bit	(0028,0102)	7
>Pixel Representation	(0028,0103)	0000H (unsigned integer)
>Pixel Data	(7FE0,0010)	Other Byte String

3.1.3. Association Acceptance Policy

The *hcserver* does not accept associations.

4. Communication Profiles

4.1. TCP/IP Stack

The *hcserver* provides DICOM V3.0 TCP/IP Network Communication Support as defined in Part 8 of the DICOM Standard.

4.1.1. TCP/IP API

The *hcserver* uses the TCP/IP stack upon which it executes.

4.1.2. Physical Media Support

The *hcserver* is indifferent to the physical medium over which TCP/IP executes.

5. Extensions/Specifications/Privatisations

N/A.

6. Configuration

The *hcserver* configuration is loaded into the running server.

6.1. AE Title/ Presentation Address Mapping

A DICOM print server is identified by a "printer name" with associated parameters such as AE title, host name and port number. The IP address corresponding to a given host name is determined using the name lookup database mechanisms provided on the hosting platform.

6.2. Definition of Target Print Servers

The list of target print servers is loaded into the running *hcserver*.

6.3. Configurable Parameters

The following parameters may be configured for the *hcserver*

Application Entity Title (Default ISG_PRINT_SCU).

Film layout formats.

Association timeout.

6.4. Support of Extended Character Sets

The *hcserver* provides no support for extended character sets in the communication with DICOM SCPs.

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