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GE Medical Systems

Technical Publications

IIS FP 10282
Revision 2

PathSpeed™ PACS Version 8.1 CONFORMANCE STATEMENT for DICOM V3.0

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Revision History

Revision	Date	Description
0	August 21, 2000	Creation of the document.
1	September 18, 2000	Add GE Private Thumbnail Image Sequence description (Appendix 1) Correct the list of modality codes for image display support.
2	April 3, 2001	Add PACS 8.1 supports: 1) CJK, 2) Unknown object support for Storage Commitment 3) Original value of renamed UID saved as private tags, 4) DICOM Print Support, and 5) Other minor changes.

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1. INTRODUCTION

1.1 OVERVIEW

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

Section 1 (Introduction) describes the overall structure, intent, and references for this Conformance Statement.

Section 2 (Network Conformance Statement) specifies compliance of the PathSpeed™ PACS DICOM Communication Server to DICOM v3.0 Standards requirements for network communication for all SOP classes it supports. This part generally follows the DICOM Standard Conformance Statement as specified in the DICOM Standard V3.0, Part 2. General network operations are described in this section. In the places that individual real-work activities should be described, references to the following sections are made, instead of including all SOP classes in this part.

Section 3 (DICOM Storage Service (SCU) Conformance Statement) specifies compliance of the PathSpeed™ PACS SOP Instance Send functions to DICOM v3.0 Standards requirements for Storage SOP Classes

Section 4 (DICOM Storage Service (SCP) Conformance Statement) specifies the compliance of the PathSpeed™ PACS SOP Instance Receive functions to DICOM v3.0 Standards requirements for Storage SOP Classes.

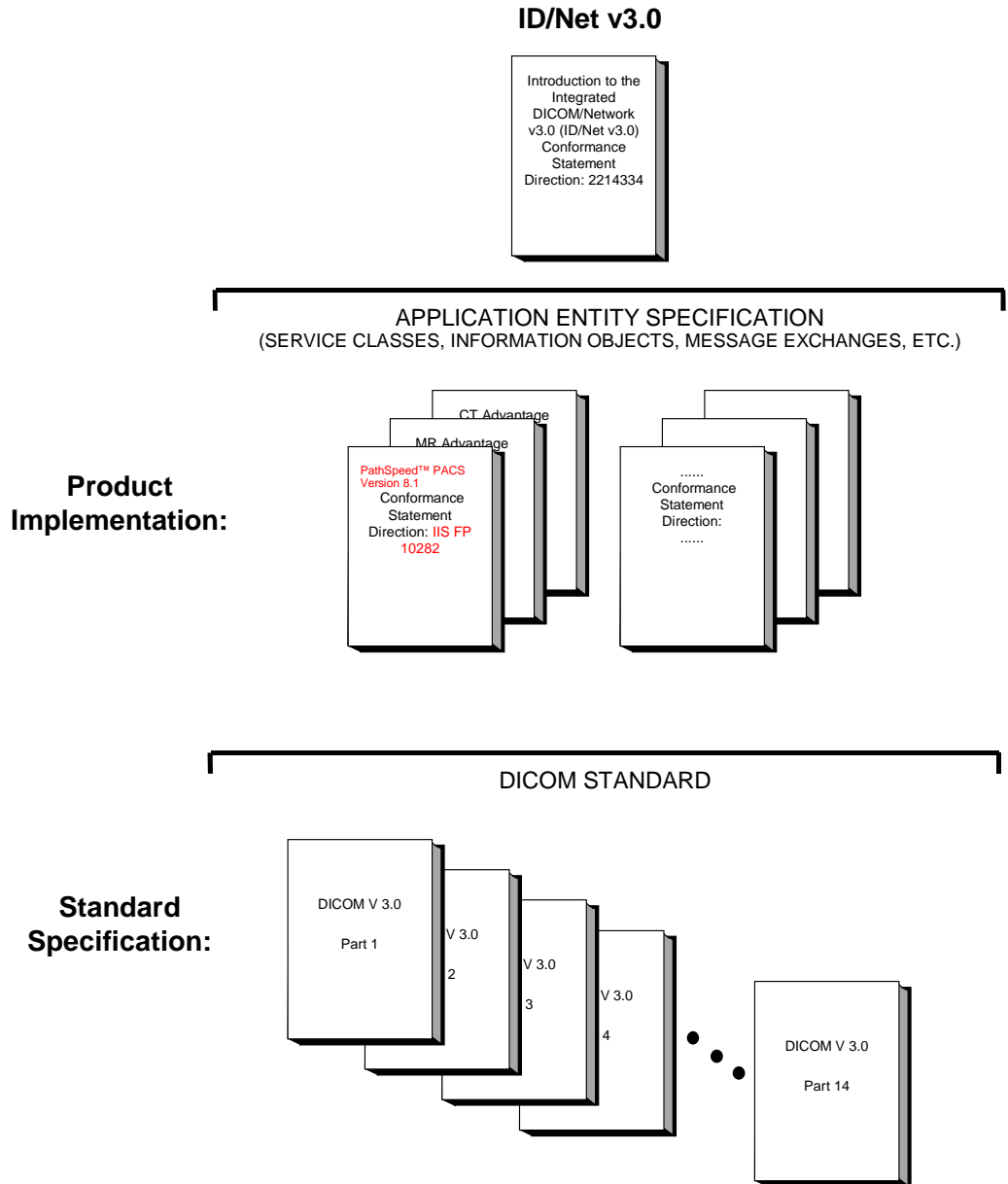
Section 5 (DICOM Query / Retrieve Service Conformance Statement) specifies the compliance of the PathSpeed™ PACS information query and data retrieval functions to DICOM v3.0 Standards requirements for Query and Retrieve SOP Classes.

Section 6 (DICOM Storage Commitment Service Conformance Statement) specifies the compliance of the PathSpeed™ PACS SOP Instance storage commitment functions to DICOM v3.0 Standards requirements for Storage Commitment SOP Classes.

Section 7 (DICOM Print Service Conformance Statement) contains a complete DICOM v3.0 Standards Conformance Statement for the print service in the PathSpeed™ PACS.

1.2 OVERALL DICOM CONFORMANCE STATEMENT DOCUMENT STRUCTURE

The Documentation Structure of the GEMS Conformance Statements and their relationship to the DICOM v3.0 Conformance Statements is shown in the illustration below.



The documentation structure given in the illustration above shows the overall documentation structure for all GE ID/Net v3.0 Conformance Statements.

ID/Net v2.0 documentation is also openly available, but the two documentation structures are independent of each other. Refer to Direction 46-269546G2.

This document specifies the DICOM v3.0 implementation supported by the GE PathSpeed™ PACS. It is entitled:

PathSpeed™ PACS Version 8.1

Conformance Statement for DICOM V3.0

Direction IIS FP 10282

This DICOM Conformance Statement documents the DICOM v3.0 Conformance Statement and Technical Specification required to inter-operate with the GE ID/Net v3.0 network interface. Introductory information, which is applicable to all GE ID/Net v3.0 Conformance Statements, is described in the document:

Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0)

Conformance Statements

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 GE 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 v3.0 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 a "collector" Direction available. By ordering the collector, the *Introduction* described above and all of the currently published GE 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 v3.0, copies of the Standard may be obtained by written request by contacting:

NEMA Publication
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209, USA

1.3 INTENDED AUDIENCE

The reader of this document is concerned with software design and/or system integration issues. It is assumed that the reader of this document is familiar with the DICOM v3.0 Standards and with the terminology and concepts, which are used in those Standards.

If readers are unfamiliar with DICOM v3.0 terminology they should first refer to the document listed below, then read the DICOM v3.0 Standard itself, prior to reading this DICOM Conformance Statement document.

Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0)

Conformance Statements

Direction: 2118780

1.4 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 GE ID/Net v3.0 implementations. This specification, called a Conformance Statement, includes a DICOM v3.0 Conformance Statement and is necessary to ensure proper processing and interpretation of GE medical data exchanged using DICOM v3.0. The GE ID/Net v3.0 Conformance Statements are available to the public.

The reader of this DICOM 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 DICOM Conformance Statement are the Module Definitions which define all data elements used by the GE ID/Net v3.0 implementation. If the user encounters unspecified private data elements while parsing a GE 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 re-transmit all of the private data elements which are sent by GEMS devices.

1.5 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 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 Standards. 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 v3.0 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 v3.0 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 Standards. Failure to do so will likely result in the loss of function and/or connectivity as the DICOM Standards change 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 / her 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.

1.6 REFERENCES

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

Additional references used in this Conformance Statement document are listed in the following table:

Document Name	Authors/Reference
GE PACS Broker v1.5.2 (Modality Worklist Interfaces) Conformance Statement for DICOM v3.0 Standards	General Electric Co., Document # MM10001

TABLE 1-1: ADDITIONAL REFERENCED DOCUMENTS

1.7 DEFINITIONS

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

1.8 SYMBOLS AND ABBREVIATIONS

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

2. NETWORK CONFORMANCE STATEMENT

2.1 INTRODUCTION

PathSpeed™ PACS provides (image and non-image) data management and archival services. It implements a DICOM Communication Server (denoted DICOM Server for short in this document) for the following services to external systems (e.g., acquisition modalities, review workstations, etc.):

- Receive DICOM Storage SOP Instances from an acquisition modality for data storage.
- Serve long-term storage commitment request for the SOP Instances. These SOP Instances can be already sent to the PACS previously or delivered at a later time after the Storage Commitment request.
- Send DICOM Storage SOP Instances to an external system for data distribution.
- Serve information query and data retrieval to the Patient / Study / Series / SOP Instances maintained in the PathSpeed™ PACS system.

The DICOM Server creates a number of DICOM Application Entities (AEs) to support these services. Each DICOM AE will be dedicated to a particular type of the DICOM services, as explained in the rest of the document.

PathSpeed™ PACS also supports the DICOM Print as SCU. The DICOM Print service has been implemented in a separate subsystem other than the DICOM Server. Section 7 includes a complete DICOM v3.0 Standards Conformance Statement for the Print service.

Note:

In this document, we use the term “DICOM Storage SOP Instance” or “SOP Instance” in places where the term “Image” is usually used. A SOP Instance generally refers to a DICOM v3.0 Standards Composite IOD, which can be an image or non-image data set. The SOP class to which an instance is associated determines the data type of the instance in the most cases. For detail, the reader is referred to DICOM PS 3.3 and 3.4, 1999.

PathSpeed™ PACS supports a RIS interface to receive study orders as well as patient / study updates. Alternatively, the PathSpeed™ Exam Manager operator can also create a study order directly in the database. PathSpeed™ PACS supports a DICOM Modality Worklist information query to the ordered studies from an acquisition modality. The modality includes the patient / study information received in the query responses to the DICOM Storage SOP instances it generates and sends these to the Storage AE of the DICOM Server.

After receiving the DICOM SOP instances, the Storage AE will match the SOP instances to the associated study in the PathSpeed™ database, using the patient / study information embedded in the data sets of the instances. Using the worklist query is highly recommended for all acquisition modalities. If a modality cannot support the worklist query, it usually relies on the operator’s input for the patient / study information. Without the use of a modality worklist, manual errors increase the number of mismatching SOP instances to the studies in the PathSpeed™ database significantly.

Modality Worklist service is optionally available using the PathSpeed™ PACS Broker but its DICOM Conformance Statement is not included in this document. For more information, refer to the PathSpeed™ PACS Broker Conformance Statements, Document # MM10001.

2.2 IMPLEMENTATION MODEL

PathSpeed™ PACS provides a number of DICOM Standard as well as private services with separate DICOM Application Entities (AEs) of the DICOM Server:

- SOP Instance Storage and Commitment Application Entity (Storage AE)
- SOP Instance Send Application Entity (Send AE)
- Information Query and Data Retrieve Application Entity (Q/R AE)

In this document, the term “The DICOM Server” refers to all of its DICOM Application Entities for their common properties and behaviors. The DICOM Server is a software module of PathSpeed™ PACS and runs on the PathSpeed™ MIU (Modality Information Unit) subsystem.

The DICOM Server is automatically started when the PathSpeed™ MIU is booted.

The following subsections give the implementation data flow diagrams of these AEs.

2.2.1 Application Data Flow Diagrams

2.2.1.1 Application Data Flow Diagram of Storage AE

The Storage AE implements both the SCP role of the DICOM Storage SOP Classes and the SCP role of the DICOM Storage Commitment SOP Class.

The SCP role of the DICOM Storage SOP classes is responsible for receiving DICOM Storage SOP Instances from a remote AE.

The SCP role of the DICOM Storage Commitment SOP class is responsible for the support of long-term Storage Commitment request from a remote AE.

There is no local real-world activity required for the Storage AE to respond incoming DICOM associations to receive SOP Instances and / or Storage Commitment requests. The Storage AE is always waiting for an incoming association and will automatically respond a Verification request.

After receiving a SOP Instance, the Storage AE will start the following local real-world activities:

1. Match the received SOP Instances to an ordered study, or create a new study (unordered study) if no match is found. This is referred as Study Profiling procedure, see Section 4.2.1.
2. Store the received SOP Instances in the PathSpeed™ PACS storage system, for use within PathSpeed™ PACS and for archiving.

Note:

The Storage AE always saves the successfully received SOP Instances, so that they will be archived. However, the Storage AE does not guarantee that the data will be archived. The remote AE submitting data to the Storage AE should verify the data archiving commitment by sending a Storage Commitment request– in the same association it sent the SOP Instances or in another dedicated, separate association.

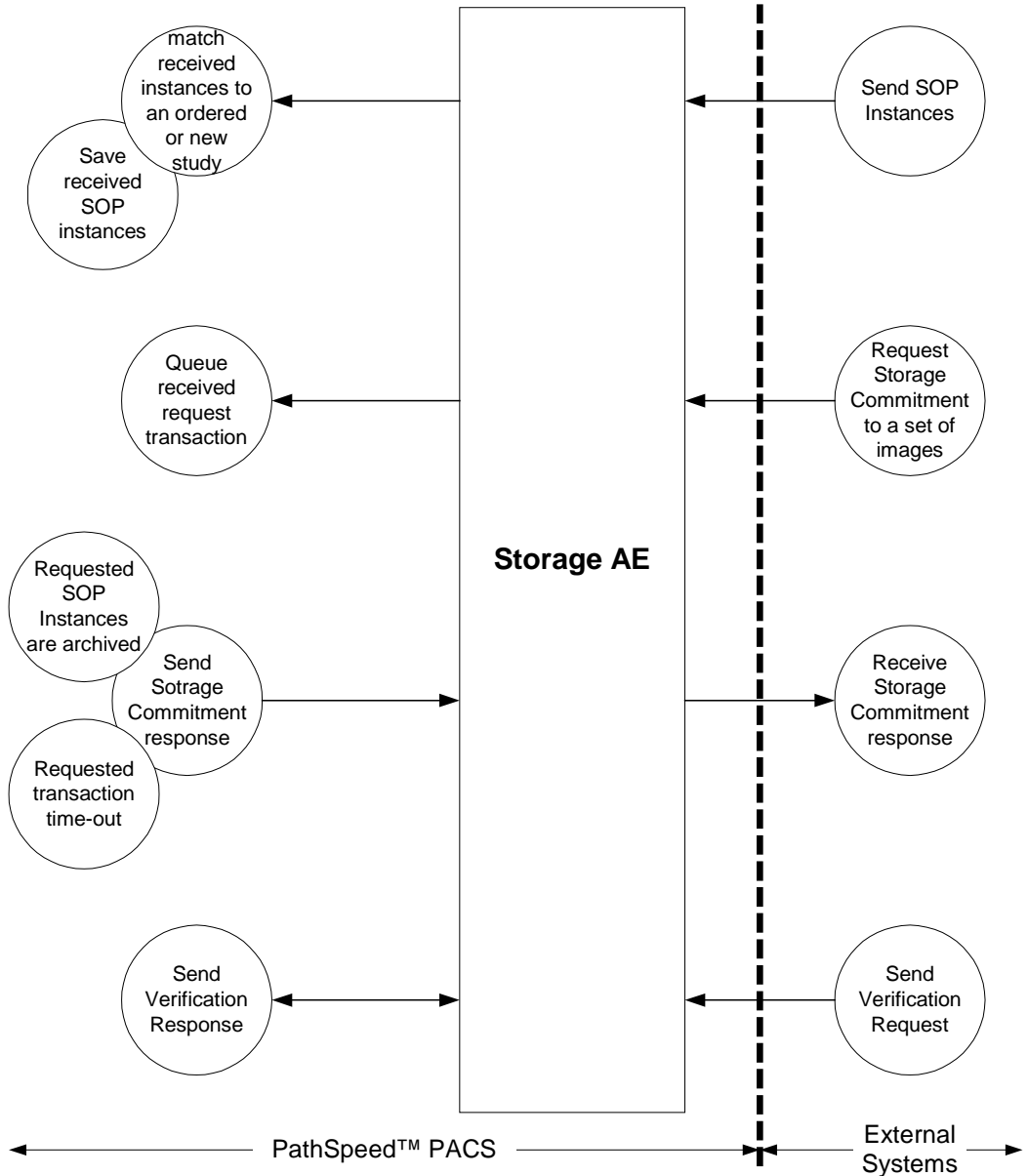


FIGURE 2-1: DATA FLOW DIAGRAM OF STORAGE AE

After receiving a Storage Commitment request, the request transaction is queued into the PathSpeed™ database (Storage Commitment Queue) and a timer of a configured time-out value (see section 2.6.5) associated with the transaction is started. The Storage AE periodically polls all outstanding Storage Commitment Transactions in the queue, and will send a Storage Commitment response back to the remote AE in the following two cases:

1. All images requested in one outstanding, queued Storage Commitment transaction have been successfully archived in the long-term archiving media.

2. The pre-configured time-out is expired, but not all images requested in one outstanding, queued Storage Commitment Transaction have been successfully archived.

The Storage AE supports a Storage Commitment request for the SOP Instances unknown to the PathSpeed™ PACS at the moment that the request is received. The Storage AE assumes that these SOP Instances will be received at a later time.

2.2.1.2 Application data flow diagram of Send AE

The Send AE implements the SCU roles of the DICOM Storage SOP Classes for sending DICOM Storage SOP Instances to a remote AE.

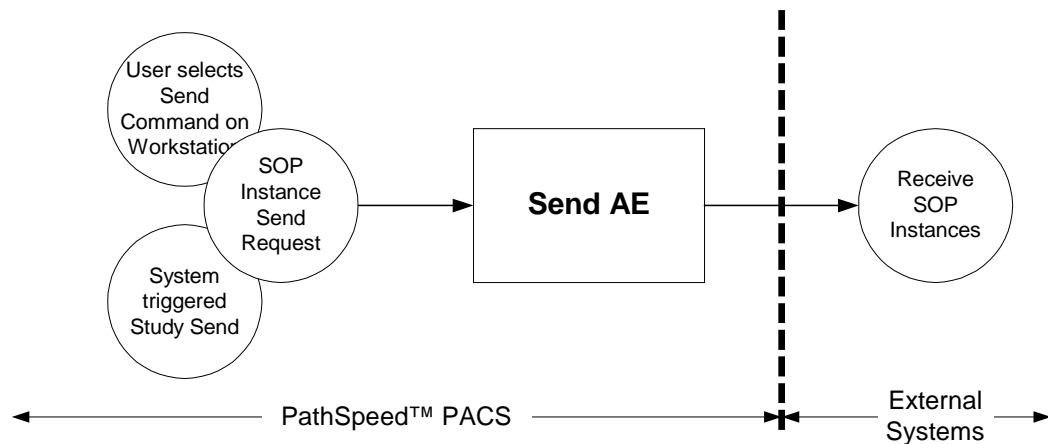


FIGURE 2-2: DATA FLOW DIAGRAM OF SEND AE

There are two real-world activities, which will cause the Send AE to initiate a DICOM association to a remote DICOM AE for sending SOP Instances:

1. A user selected a DICOM Push command on the PathSpeed™ Workstation for a specified study to a specified destination DICOM AE.
2. A study changed its status to a particular value, which is pre-configured in the PathSpeed™ PACS to trigger a DICOM Send of the study to a specified destination DICOM AE.

Note: The trigger mechanism and the configuration method for these triggers are beyond the scope of this document.

2.2.1.3 Application data flow diagram of Q/R AE

The Q/R AE implements the SCP role of the DICOM Query / Retrieve SOP Classes for a remote AE to query the Patient / Study / Series / SOP Instance information, as well as to retrieve the SOP Instances from PathSpeed™ PACS.

As the DICOM Query / Retrieve SCP for data retrieval, the Q/R AE also implements the SCU role of the Storage SOP Classes for the SOP Instances move sub-operations.

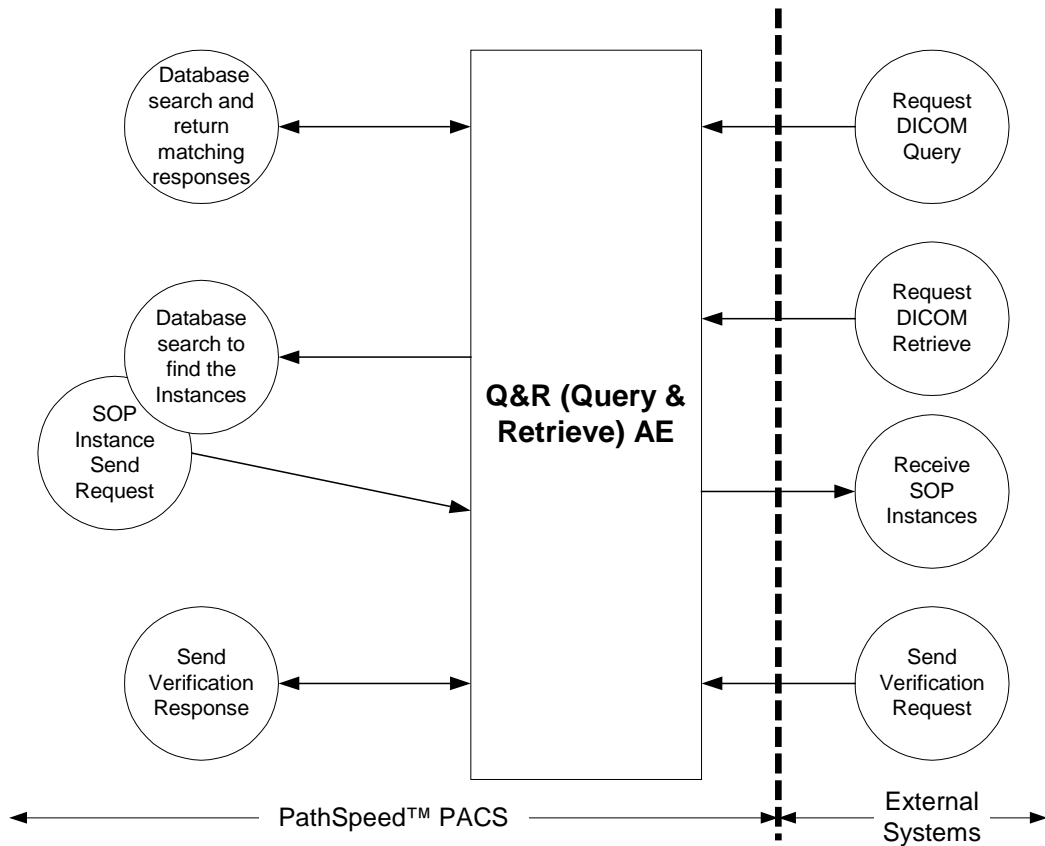


FIGURE 2-3 DATA FLOW DIAGRAM OF Q/R AE

There is no real-world activity required for the Q/R AE to respond to incoming DICOM associations for DICOM Query and Retrieve. The Q/R AE is always waiting for an incoming association and will automatically respond a DICOM Verification request.

After receiving DICOM Query request, the Q/R AE will start the following local real-world activities:

1. Search for the requested data attributes on the Patient / Study / Series / SOP Instance levels in the PathSpeed™ database, as specified in the Query request and using the matching criteria specified in the Query request.
2. Return all matching responses.

After receiving DICOM Retrieve request, the Q/R AE will start the following local real-world activities:

3. Search for the SOP Instances records on the Patient / Study / Series / SOP Instance level in the PathSpeed™ database, as specified in the Retrieve request and using the matching criteria specified in the Retrieve request.
4. Locate the data files of the found SOP Instances in the PathSpeed™ storage sub-system. Fetch the data from the long-term archiving sub-system if necessary.
5. If the data files can be located, initiate a separate DICOM association to send these to the destination AE as specified in the received Retrieve request.

2.2.2 Functional Definitions of AE's

The DICOM Application Entities of PathSpeed™ PACS initiate or receive the DICOM associations to support a number of application functions for the PACS system.

2.2.2.1 Storage AE

The Storage AE supports the following application-level functions:

- Receive SOP instances from a remote DICOM AE.
- Relate each received instance to an ordered / scheduled study in the PathSpeed™ PACS database by matching the Patient / Study information in the instance's data set to the information of the database.
- If no matching can be found, create a new (unordered) study by directly using the Patient / Study information in the received data set and relate the SOP instance to the created study.

Note:

When relating a SOP Instance to an ordered study, the Storage AE may alter the values of some data elements using the values of the counterpart data fields of the matched study in the PathSpeed™ database. In addition, the SOP Instances may be also changed by the Patient / Study update information received from RIS or entered by the PathSpeed™ Exam Manager operator. PathSpeed™ PACS does not create a new SOP Instance for these data changes. A later DICOM Query or Retrieve request from remote AE will receive the SOP Instance with some data elements changed, or may not find the submitted SOP Instance if the changed data elements are used as the searching keys. A list of the data elements that may undergo data coercion is given in Section 4.2.3. Data coercion is performed for data correction purpose.

- Store the Patient, Study, Series, and SOP Instance relationship permanently in the PathSpeed™ PACS database.
- Store the SOP instances in the PACS storage system, for use within PathSpeed™ PACS and for long-term archiving.

Note:

PathSpeed™ PACS will properly save and archive all SOP Instances successfully received via the Storage AE. However, PathSpeed™ PACS cannot guarantee that all received SOP Instances can be properly displayed and printed. Section 4.2.4 lists the detailed application-level functions that PathSpeed™ PACS is able to support for the successfully received SOP Instances.

- Receive a DICOM Storage Commitment request from a remote AE.
- Create a job (transaction) and add it in the PathSpeed™ PACS Storage Commitment Queue. The job is identified by the transaction UID in the received request and associated with a timer of a configurable time-out value (see Section 2.6.5).
- Poll the Storage Commitment Queue for a job, which is either completed or time-out.
- Send Storage Commitment response to remote AE.
- Respond to a DICOM Verification (Echo) request from a remote AE.

2.2.2.2 Send AE

The Send AE supports the following application-level function:

- Send the SOP Instances of a study maintained in PathSpeed™ PACS to a remote AE.

Note: Due to the data coercion, the SOP Instances sent to a remote AE may be different from the originally received SOP Instances in certain data elements. See Section 4.2.3 for possible data corrections in PathSpeed™ PACS.

2.2.2.3 Q/R AE

The Q/R AE supports the following application-level functions:

- Receive a DICOM Query request at Patient / Study / Series / SOP Instance levels from a remote AE.
- Search for the data attributes in the PathSpeed™ database that match the requested matching keys
- Respond to the remote AE by returning all matched data sets

Note: Due to the data coercion, the values of certain returned keys in the Query responses may be different from the values of the corresponding data element in the SOP Instances originally sent the Storage AE. See Section 4.2.3 for possible data corrections in PathSpeed™ PACS.

- Receive a DICOM Retrieve request at Patient / Study / Series / SOP Instance levels from a remote AE
- Find the requested SOP Instances in PathSpeed™ PACS, against both the on-line storage subsystem and the long-term archiving subsystem.
- Send the matched and found SOP Instances to the specified destination AE.

Note: Due to the data coercion, the SOP Instances moved to a remote AE may be different from the originally received SOP Instances in certain data elements. See Section 4.2.3 for possible data corrections in PathSpeed™ PACS.

- Respond to a DICOM Verification (Echo) request from a remote AE.

2.2.3 Sequencing of Real-World Activities

Not applicable.

2.3 STANDARD SPECIFICATION

The Send AE provides the Standard Conformance to the following DICOM v3.0 Standard SOP Classes and Private SOP Class as SCU:

SOP Class Name	SOP Class UID
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1
X-ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1
X-ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1
Digital Mammography Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.2
Digital Mammography Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.2.1
Digital X-Ray Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.1
Digital X-Ray Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.1.1
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4
Ultrasound Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.6
Ultrasound Multi-Frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.3
X-ray Angiographic Bi-plane Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.12.3
GE Private 3D Model Storage	1.2.840.113619.4.26
GE Advance (PET) Raw Data Storage	1.2.840.113619.4.30
GEPACS_PRIVATE_IMS_INFO Storage	2.16.840.1.113709.1.5.1

TABLE 2-1: SCU CONFORMANCE LIST OF SOP CLASSES FOR SEND AE

The Storage AE provides the Standard Conformance to the following DICOM v3.0 Standard SOP Classes and Private SOP Class as SCP:

SOP Class Name	SOP Class UID
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1
X-ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1

X-ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1
Digital Mammography Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.2
Digital Mammography Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.2.1
Digital X-Ray Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.1
Digital X-Ray Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.1.1
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4
Ultrasound Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.6
Ultrasound Multi-Frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.3
X-ray Angiographic Bi-plane Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.12.3
GE Private 3D Model Storage	1.2.840.113619.4.26
GE Advance (PET) Raw Data Storage	1.2.840.113619.4.30
GEPACS_PRIVATE_IMS_INFO Storage	2.16.840.1.113709.1.5.1
Storage Commitment Push Model	1.2.840.10008.1.20.1
Verification (Echo)	1.2.840.10008.1.1

TABLE 2-2: SCP CONFORMANCE LIST OF SOP CLASSES FOR STORAGE AE

The Q/R AE provide the Standard Conformance to the following DICOM v3.0 Standard SOP Classes as SCP:

SOP Class Name	SOP Class UID
Patient Root Query / Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.1.1
Study Root Query / Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1
Patient Root Query / Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.1.2
Study Root Query / Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2
Verification (Echo)	1.2.840.10008.1.1

TABLE 2-3: SCP CONFORMANCE LIST OF SOP CLASSES FOR Q/R AE

The Q/R AE provides Standard Conformance to the DICOM v3.0 Standard SOP Classes listed in Table 2-1 as SCU for the C-STORE sub-operation initiated in a C-MOVE context.

2.3.1 Association Establishment Policies

This section describes the common behaviors of the all AEs of the DICOM Server with respect to the DICOM network association establishment. Specific behaviors of each individual AE will be described in Sections 2.3.2 and 2.3.3

2.3.1.1 General

The DICOM Application Context Name (ACN), which is always proposed by the DICOM Server, is

DICOM Application Context Name	1.2.840.10008.3.1.1.1
--------------------------------	-----------------------

The Maximum Length of PDU negotiation is included in all association establishment requests. The Maximum Length of PDU proposed for all associations initiated by the DICOM Server is configurable (see Section 2.6.7) up to

Maximum Length of PDU	28672 Bytes
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The number given above (28672 Bytes) is also the Maximum Length of PDU in all DICOM associations that the DICOM Server can accept.

The DICOM Server does not support SOP class Extended Negotiation in any DICOM associations its AEs accept.

The Storage AE of the DICOM Server will propose (SCU/SCP) Role Selection Negotiation in a DICOM association it initiates for sending the Storage Commitment Reports.

Other AEs of the DICOM Server will not propose (SCU/SCP) Role Selection Negotiation in any DICOM associations they initiate.

The user information items sent by the AEs of the DICOM Server are

- Maximum Length of PDU
- Implementation Class UID
- Implementation Version Name

2.3.1.2 Number of Associations

The DICOM Server is able to initiate and accept multiple DICOM associations at a time to perform DIMSE service elements. The maximum numbers of the simultaneous DICOM associations that can be initiated and accepted are configurable for the DICOM Server, but not for separate AEs (see Section 2.6.2).

Table 2-4 shows how the relationship between the separate AEs and the maximum numbers of the simultaneous DICOM associations that the DICOM Server can support. The numbers in Table 2-4 are default values.

AE	Association Purpose	Default Maximum Number of Associations	
		Initiation	Acceptance
Send AE	Send SOP Instances	2	—
Storage AE	Send Storage Commitment Report	1	—
Storage AE	Receive SOP Instances	—	total 20
Q/R AE	Serve Query / Retrieve Requests	—	
Q/R AE	Sub-ops for moving SOP Instances	—	

TABLE 2-4: THE DEFAULT MAXIMUM NUMBERS OF THE SIMULTANEOUS ASSOCIATIONS SUPPORTED BY THE AEs OF THE DICOM SERVER

As shown in Table 2-4, by default, the DICOM Server is able to initiate totally 2 simultaneous associations for sending the SOP Instances. This includes execution of the Image Send commands

issued by the PathSpeed™ PACS system or users. For the Storage Commitment report, the Storage AE will always initiate one single association.

By default, the DICOM Server is able to support maximum 20 simultaneous associations total for receiving SOP Instances and Storage Commitment requests, as well as to serving Query / Retrieve requests. This includes all additional associations required for sending SOP Instances as the store sub-operations resulted by serving a DICOM Retrieve request. The DICOM server does not restrict the number of maximum simultaneous associations individually for the separate services and serves the incoming associations on a first-come-first-serve basis, until the configured maximum number is reached.

Note: PathSpeed™ PACS supports multiple instances of the DICOM Server running simultaneously. If the number of simultaneous associations supported by a single DICOM Server is not sufficient, multiple PathSpeed™ MIU subsystems can be configured.

2.3.1.3 Asynchronous Nature

None of the DICOM Server AE's supports asynchronous operations. All operations will be performed synchronously.

2.3.1.4 Implementation Identifying Information

All AEs of the DICOM Server provide the same implementation class UID, which is:

Implementation Class UID	2.16.840.1.113709.1.1.1
--------------------------	-------------------------

All AEs of the DICOM Server provide the same implementation version name, which is:

Implementation Version Name	PathSpeed_8.1
-----------------------------	---------------

2.3.1.5 Timers

2.3.1.5.1 Association Timers

The DICOM Server supports an association timer for an association that the DICOM Server plays the role of association initiator.

The association timer starts when the association request is sent, and stops when the association is established.

2.3.1.5.2 Operation Inactivity Timer

The DICOM Server supports an operation inactivity timer in each association.

For the role of association initiator, the operation inactivity timer re-starts every time a DIMSE service request has been issued.

For the role of association acceptor, the operation inactivity timer re-starts every time a DIMSE service response has been sent.

2.3.2 Association Initiation Policies

All AEs of the DICOM Server can be configured to initiate association establishment only to remote AEs defined in a Remote AE list for the initiation of DICOM associations. The Remote AEs are specified with the Remote AE Titles as well as the network presentation addresses in the remote AE lists configured for the DICOM Server (see Section 2.6.1).

The calling AE Titles can be configured for each AE of the DICOM Server.

2.3.2.1 Real-World Activity: Send SOP Instance(s) to Remote AE

The Send AE will perform C-STORE operation to support this real-world activity.

A list of remote AE can be configured, so that the Send AE will initiate associations only to these AEs for sending SOP Instances. This includes the C-STORE sub-operation association initiation within a C-MOVE association. This configuration capability allows the user control of the valid DICOM Retrieve destinations.

For the DICOM Conformance Statement of this operation, please refer to Section 3.1 (page 3–25).

2.3.2.2 Real-World Activity: Send Storage Commitment Response to Remote AE

The Storage AE will perform N-EVENT-REPORT operation to support this real-world activity.

The Storage AE will initiate associations only to remote AE, which previously requested a DICOM Storage Commitment transaction.

For the DICOM Conformance Statement of this operation, please refer to Section 6.2 (page 6–51).

2.3.3 Association Acceptance Policies

Each AE of the DICOM Server accepts incoming association requests on their dedicated TCP port numbers as defined in the configuration file (see Section 2.6.1). They will accept an association, if at least one proposed presentation context is acceptable.

If a remote AE presents multiple presentation syntaxes for the same abstract syntax in one DICOM association,

The DICOM Server can be configured to accept one or several particular transfer syntaxes for the same abstract syntax, if a remote AE presents these presentation syntaxes.

All AEs of the DICOM Server can be configured to accept association requests only from specific remote AEs defined in a Remote AE list (see Section 2.6.1). The remote AEs are specified with the AE Titles as well as with the network presentation addresses in the Remote AE list, configured for the DICOM Server (see Section 2.6.1). This behavior of the DICOM Server helps the user to control the remote AE's access for data archiving, storage commitment, Query / Retrieve services of PathSpeed™ PACS.

The called AE Titles can be configured for each AE of the DICOM Server.

The DICOM Server will check both the calling and called AE Titles for the acceptance of an incoming association.

Association requests can be rejected with the following status codes and reasons:

Result	Source	Reason	Description
Rejected (transient)	UL-service provider	Temporary congestion	Resource limitation: process creation failed, memory allocation failed, etc.
Rejected (transient)	UL-service provider	PathSpeed™ PACS internal service down	Database network connection down, image storage network connection down, etc.
Rejected (permanent)	UL-service user	Application context name not supported	Incorrect (unknown) application context name
Rejected (permanent)	UL-service user	Calling AE Title unknown or not supported	The calling AE Title is not included in the configuration list, or the calling AE is not supported by the called AE Title.
Rejected (permanent)	UL-service user	Called AE Title unknown or not supported	The called AE Title is unknown to the DICOM Server, or the calling AE is not supported by the called AE Title.

TABLE 2-5: ASSOCIATION REJECT STATUS CODES AND REASONS

2.3.3.1 Real-World Activity: Receive DICOM SOP Instances from Remote AE

The Storage AE supports the C-STORE operation for this service.

For the DICOM Conformance Statement of this service, please refer to Section 4.1 (page 4–29).

2.3.3.2 Real-World Activity: Storage Commitment Request from Remote AE

The Storage AE supports the N-ACTION operation for this service.

For the DICOM Conformance Statement of this service, please refer to Section 6.1 (page 6–49).

2.3.3.3 Real-World Activity: DICOM Query Request from Remote AE

The Q/R AE supports the C-FIND operation for this service.

For the DICOM Conformance Statement of this service, please refer to Section 5.1 (page 5–42).

2.3.3.4 Real-World Activity: DICOM Retrieve Request from Remote AE

The Q/R AE supports the C-MOVE operation for this service. In addition, the Q/R AE will perform a sub-operation C-STORE to transmit the requested SOP Instances.

For the DICOM Conformance Statement of this service, please refer to Section 5.2 (page 5–46).

2.3.3.5 Real-World Activity: DICOM Verification (Echo) Request from Remote AE

Both the Storage AE and the Q/R AE support the C-ECHO operation for this service.

For the DICOM Conformance Statement of this service, please refer to Section 4.1 (page 4–29) and Section 5.1 (page 5–42).

2.4 COMMUNICATION PROFILE

2.4.1 Supported Communication Stacks

DICOM Upper Layer (DICOM PS 3.8-1999) is supported by using TCP/IP.

2.4.2 TCP/IP Stack

TCP/IP Network Communication is supported as specified in DICOM PS 3.8-1999.

2.4.3 OSI Stack

Not supported

2.4.4 Physical Media Support

Various network links are supported, including but not limited to 10-BaseT Ethernet, 100-BaseT Ethernet, and ATM OC-3.

The physical media supported depends on network cabling and interfaces equipment available at the PathSpeed™ PACS installation site and interface equipment commercially available.

Equipment list and configuration information for the physical media supported is available upon request.

2.5 EXTENSIONS / SPECIALIZATION / PRIVATIZATION

2.5.1 Extension / Specialization SOP Classes

The DICOM Server supports the extensions to the DICOM v3.0 Standard Storage SOP Classes as listed in Table 2-1 and Table 2-2. Private or standard extended data elements will be accepted for storage and archiving, and supported for SOP Instance sending and retrieve.

The DICOM Server does not support any Specialization SOP Classes.

2.5.2 Privatized SOP Classes

The DICOM Server supports the following Private SOP Class:

GEPACS_PRIVATE_IMS_INFO STORAGE	2.16.840.1.113709.1.5.1
GE Private 3D Model Storage	1.2.840.113619.4.26
GE Advance (PET) Raw Data Storage	1.2.840.113619.4.30

This private SOP class has been applied exclusively for the data exchange between two PathSpeed™ PACS installation sites. Therefore, the definition of the GEPACS_PRIVATE_IMS IOD is not

published in this Conformance Statement document. It is expected that other vendors' applications will ignore all presentation contexts proposed for the GEPACS_PRIVATE_IMS Storage SOP Class.

2.5.3 Privatized Transfer Syntax

The DICOM Server supports the following Private transfer syntax:

COMPRESS_EXPRESS TRANSFER SYNTAX	2.16.840.1.113709.1.2.2
----------------------------------	-------------------------

This private transfer syntax has been applied for the DICOM Server to propose and accept the presentation syntaxes for all DICOM v3.0 Standards Storage SOP Classes that the DICOM Server supports (see Sections 3 and 4). It uses Explicit VR and Big Endian format for the data set encoding, and the GE proprietary CompressXpress™ and TruRez™ image compression algorithms for the pixel data compression. No pixel data encapsulation is applied.

It is expected that other vendors' applications will ignore all presentation contexts proposed with the COMPRESS_EXPRESS transfer syntax.

2.6 CONFIGURATION

The exact method for configuring each configurable item is specified in other PathSpeed™ PACS documentation. The following sections only describe some items that are configurable.

2.6.1 AE Title/Presentation Address Mapping

2.6.1.1 Local AE Title

AE Titles of the Storage AE for receiving SOP Instances and Storage Commitment requests

AE Titles of the Storage AE for sending Storage Commitment responses

AE Titles of the Send AE for sending SOP Instances

AE Titles of the Q/R AE for serving the DICOM Query and Retrieve request

AE Titles of the Q/R AE for sending SOP Instances in response to C-MOVE operation

2.6.1.2 Remote AE Title

AE Titles of the remote AEs with that the DICOM Server will interact for receiving / sending SOP Instance, serving Storage Commitment request and Query / Retrieve requests.

2.6.1.3 AE Title / Presentation Address Mapping

A local mechanism is provided to configure an AE Title / Presentation Address mapping table. This table contains the following data items for each AE entry:

- AE Title
- AE Name

- TCP/IP addresses
- TCP Port Number

2.6.2 Maximum Simultaneous Associations

The maximum number of simultaneous associations that the Send AE and the Q/R AE can initiate, can be configured. The default value is 2.

The maximum number of simultaneous associations that the Storage AE and the Q/R AE can accept, can be configured. The default value is 20.

2.6.3 AE Title / Accepted Association Mapping

A local mechanism is provided to configure

- A list of remote AEs that are permitted to send SOP Instances and to request Storage Commitment to the Storage AE
- A list of remote AEs that are permitted to query Patient / Study / Series / SOP Instances information and to retrieve SOP Instances from Q/R AE

2.6.4 AE Title / Association Initiation Mapping

A local mechanism is provided to configure

- A list of remote AEs, to which the Storage AE and the Q/R AE can initiate an association to send the SOP Instances.

2.6.5 Server Time-out

Association time-out

Association operation inactivity time-out

Storage Commitment Job time-out

2.6.6 Message Validation

The Storage AE can validate incoming DICOM messages to see if the messages conform to the DICOM v3.0 Standards. A configuration option turns this checking on or off.

2.6.7 Maximum PDU Size Accepted

The Maximum Length of PDU negotiated by the DICOM Server is configurable up to the maximum value of 28672 bytes.

2.7 SUPPORT FOR EXTENDED CHARACTER SETS

The DICOM Server supports following character sets:

- ISO-IR-6 (ISO 646)
- ISO-IR-100 (ISO 8859-1)

- ISO-IR-13
- ISO-IR-14
- ISO-IR-87
- ISO-IR-149
- ISO-IR-165

In some Application Entities of the DICOM Server, restriction may apply to the extended character sets, see sub-sections “Extended Character Sets” in Sections 3 - 6 for the Extended Character Sets support scopes for each Application Entities.

3. DICOM STORAGE SERVICE (SCU) CONFORMANCE STATEMENT

This section describes the conformance statement for the data sending functions supported in PathSpeed™ PACS. They are implemented in the Send AE as the SCU role of the DICOM Storage SOP Classes.

3.1 SEND SOP INSTANCE TO REMOTE AE

The Send AE initiates a DICOM association for sending DICOM Storage SOP instances to remote AE by performing the C-STORE operations.

The Send AE is able to initiate multiple DICOM associations to remote AE simultaneously. The maximum number of the concurrent associations that the Send AE can initiate for sending the SOP Instances, is configurable (see Section 2.6.2 and Table 2-4).

3.1.1 Associated Real-World Activities

The Send AE will initiate a DICOM association for sending one or several SOP instances to remote AE in response to the following real-world activities:

1. A user initiated a DICOM Send command for a specified study with a specified destination AE on the PathSpeed™ Workstation.
2. The PathSpeed™ PACS has been configured to send a study to a specified destination AE when the study's status changes to a specified value, and this condition occurs.

3.1.2 Proposed Presentation Context Table

The following table shows the transfer syntaxes that the Send AE uses to propose the Presentation Contexts:

Transfer Syntax Table		
List Name	Name List	UID List
Transfer Syntax List 1	COMPRESS_EXPRESS	2.16.840.1.113709.1.2.2
	Explicit VR Big Endian	1.2.840.10008.1.2.2
	Explicit VR Little Endian	1.2.840.10008.1.2.1
	Implicit VR Little Endian	1.2.840.10008.1.2
Transfer Syntax List 2	Explicit VR Big Endian	1.2.840.10008.1.2.2
	Explicit VR Little Endian	1.2.840.10008.1.2.1
	Implicit VR Little Endian	1.2.840.10008.1.2
Transfer Syntax List 3	JPEG Baseline 1	1.2.840.10008.1.2.4.50

TABLE 3-1: TRANSFER SYNTAXES USED IN PRESENTATION CONTEXTS PROPOSED BY SEND AE

The transfer syntaxes are grouped in three lists. In each presentation context, one list of the transfer syntaxes is proposed.

The following table show the presentation contexts proposed by the Send AE after the real-world activity “Send DICOM Instance” (see Figure 2-2) has been performed

Presentation Context Table				
Abstract Syntax		Transfer Syntax	Role	Extended Negotiation
SOP Class	UID			
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	Transfer Syntax List 1	SCU	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2		SCU	None
MR Image Storage	1.2.840.10008.5.1.4.1.1.4		SCU	None
Secondary Capture Image	1.2.840.10008.5.1.4.1.1.7		SCU	None
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20		SCU	None
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1		SCU	None
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1		SCU	None
X-ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1		SCU	None
X-ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2		SCU	None
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1		SCU	None
Digital Mammography Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.2		SCU	None
Digital Mammography Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.2.1		SCU	None
Digital X-Ray Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.1		SCU	None
Digital X-Ray Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.1.1		SCU	None
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128		SCU	None
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	SCU	None	
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2	Transfer Syntax List 3	SCU	None
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3	SCU	None	
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4	SCU	None	
Ultrasound Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.6	SCU	None	
Ultrasound Multi-Frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.3	SCU	None	
X-ray Angiographic Bi-plane Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.12.3	SCU	None	
GE Private 3D Model Storage	1.2.840.113619.4.26	SCU	None	
GE Advance (PET) Raw Data Storage	1.2.840.113619.4.30	SCU	None	
GEPACS_PRIVATE_IMS_I NFO Storage	2.16.840.1.113709.1.5.1	Transfer Syntax List 2	SCU	None

TABLE 3-2: PROPOSED PRESENTATION CONTEXT FOR STORAGE SCU

As shown in Table 3-2, the Send AE will propose two presentation contexts for some abstract syntaxes, respectively with Transfer Syntax List 1 and Transfer Syntax List 2. This behavior is configurable. The DICOM Server can be configured only to propose transfer syntaxes in one list, if it is desired.

In order to send a SOP Instance, the Send AE requires its stored transfer syntax in PathSpeed™ PACS falls in the same Transfer Syntax List of the transfer syntax that the SCP selected for the accepted presentation context. Otherwise, the Send AE will be not able to send the SOP Instance.

3.1.2.1 SOP Specific Conformance Statement for All Storage SOP Classes

The Send AE provides standard conformance to the DICOM Standard Storage Service Class as SCU for all storage SOP classes listed in Table 3-2.

The Send AE will invoke DIMSE C-STORE service element to perform the SOP Instance Send operation.

All optional elements, which exist in the Storage SOP Instance, will be sent. The existence of optional elements depends on the equipment sending images to PathSpeed™ PACS.

All private elements, which exist in the Storage SOP Instance, will be sent. The existence of private elements depends on the equipment sending images to PathSpeed™ PACS.

Non-DICOM images stored on PathSpeed™ PACS will be converted DICOM Secondary Capture SOP Class, and transmitted by performing the C-STORE operation.

The Send AE does not use the C-STORE priority attribute.

Note: As pointed out previously, SOP Instances sent to the remote AE may have undergone correction / modification in certain data elements. A list of the data elements that may undergo data coercion is given in Section 4.2.3.

The implementation of the Send AE can perform multiple C-STORE operations over one single association. The Send AE will propose all presentation contexts as the list of SOP Instances to be sent dictates, and send all SOP Instances as long as the required presentation context are accepted.

Upon receiving a C-STORE-RSP containing a successful status, the Send AE will perform the next C-STORE operation. The association will be maintained if possible.

Upon receiving a C-STORE-RSP containing a Refused status, the Send AE will terminate the association. The remaining SOP Instances are not transmitted.

Upon receiving a C-STORE-RSP which contains any status that is not Success or Refused, the Send AE will consider the current request to be failure, but will continue to attempt to send the remaining SOP Instances on the same association.

If any of the timers (see Section 2.3.1.5) expires, the connection is closed and the operation in progress is considered failed.

In any case, the SOP Instances sent are always retained in PathSpeed™ PACS.

3.1.3 Extended Character Sets

The DICOM Server may perform a data coercion in a SOP Instance sent out, in order to update the data set with the information maintained in the PathSpeed™ database. The Patient Name (0010,0010) may be multi-valued to include Ideographic and Phonetic name groups in addition to Alphabetic Name. This will be done if the receiving AE has been configured to intend to receive these additional names and these are available in PathSpeed™ database. While the Alphabetic Name is always encoded with ISO-IR-8859-1 character sets, the Ideographic and Phonetic Names can be encoded with other dual-byte character sets as listed in Section 2.7. In the current release, the DICOM Server will not add text information encoded with extended character sets into other data elements.

See PathSpeed™ service documentation for the peer AE configuration method.

4. DICOM STORAGE SERVICE (SCP) CONFORMANCE STATEMENT

This section describes the conformance statement for the data receiving functions supported in PathSpeed™ PACS. They are implemented in the Storage AE as the SCP role of the DICOM Storage SOP Classes.

4.1 RECEIVE STORAGE SOP INSTANCE FROM REMOTE AE

The Storage AE constantly listens for incoming associations to receive DICOM Storage SOP instances from a remote AE.

The Storage AE is able to serve multiple DICOM associations simultaneously. The maximum number of the concurrent associations that the Storage AE can accept for receiving the SOP Instances, is configurable (see Section 2.6.2 and Table 2-4).

4.1.1 Associated Real-World Activities

The following real-world activities are associated with the Receive Storage SOP Instance operation (refer to Figure 2-1):

1. A physician orders a study for the patient at RIS. At the time the study is ordered, the RIS sends the study order and patient information to PathSpeed™ PACS, which creates an ordered study in consequence and expects to receive SOP Instances associated with this study.
2. The patient arrives in the Radiology department for the study. Either the modality is able to query the modality worklist from PathSpeed™ PACS (see Section 2.1) or a technologist brings the patient study information up on the modality. The technologist then performs the study on the patient.
3. Based on the patient / study information queried from PathSpeed™ PACS or entered manually, the modality generates the DICOM Storage SOP instances as the results of the study and sends these to the Storage AE of PathSpeed™ PACS.
4. The Storage AE matches the DICOM objects received from the modality to an ordered study in the database. This is referred to as Study Profiling, see Section 4.2.1.

4.1.2 Acceptable Presentation Context

The following table shows the presentation contexts acceptable for the Storage AE for receiving DICOM Storage SOP Instances:

Presentation Context Table							
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation		
SOP Class	UID	Name List	UID List				
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	COMPRESS_EXPRESS	2.16.840.1.113709.1.2.2	SCP	None		
CT Image Storage	1.2.840.10008.5.1.4.1.1.2			SCP	None		
MR Image Storage	1.2.840.10008.5.1.4.1.1.4			SCP	None		
Secondary Capture Image	1.2.840.10008.5.1.4.1.1.7			SCP	None		
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20			SCP	None		
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	Explicit VR Big Endian	1.2.840.10008.1.2.2	SCP	None		
Ultrasound Multi-Frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1			SCP	None		
X-ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1			SCP	None		
X-ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2			SCP	None		
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1			SCP	None		
Digital Mammography Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.2			SCP	None		
Digital Mammography Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.2.1			Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
Digital X-Ray Image Storage (for presentation)	1.2.840.10008.5.1.4.1.1.1.1					SCP	None
Digital X-Ray Image Storage (for processing)	1.2.840.10008.5.1.4.1.1.1.1.1					SCP	None
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128					SCP	None
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None		
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2			SCP	None		
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3			SCP	None		
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4			SCP	None		
Ultrasound Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.6	JPEG Baseline 1	1.2.840.10008.1.2.4.50	SCP	None		
Ultrasound Multi-Frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.3			SCP	None		
X-ray Angiographic Bi-plane Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.12.3			SCP	None		
GE Private 3D Model Storage	1.2.840.113619.4.26			SCP	None		
GE Advance (PET) Raw Data Storage	1.2.840.113619.4.30			SCP	None		
Storage Commitment Push Model	1.2.840.10008.1.20.1	Explicit VR Big Endian	1.2.840.10008.1.2.2	SCP	SCP/SCU Role Selection		
Verification (DICOM Echo)	1.2.840.10008.1.1	Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None		
GEPACS_PRIVATE_IMS_I NFO Storage	2.16.840.1.113709.1.5.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None		

TABLE 4-1: ACCEPTABLE PRESENTATION CONTEXT

The columns Transfer Syntax in Table 4-1 lists all transfer syntaxes that the Storage AE can accept for the DICOM presentation contexts proposed for the specified abstract syntaxes. The DICOM Server can be configured to accept one or several or all of these transfer syntaxes for each abstract syntax.

If several transfer syntaxes are present in a presentation context, the Store AE will select a transfer syntax in the order as listed in Table 4-1.

4.1.2.1 SOP Specific Conformance Statement for Verification Service Class

The Storage AE provides standard conformance to the DICOM Verification Service Class as SCP.

4.1.2.2 SOP Specific Conformance Statement for Storage Commitment SOP Class

The Storage AE also accepts presentation context for the DICOM Storage Commitment – PUSH Model SOP Class. For the conformance statement for this behavior, the reader is referred to Section 6.1.

4.1.2.3 SOP Specific Conformance Statement for All Storage SOP Classes

The Storage AE provides standard conformance to the DICOM Storage Service Class as SCP.

No specialized or privatized Storage SOP Class can be accepted.

4.1.2.3.1 General Behavior for all Storage SOP Classes

The SCP conforms to the DICOM Storage SOP Classes at Level 2 (full) as specified in DICOM PS 3.4-1999, Appendix B.4.1. No elements are discarded.

All private data elements (including Unknown VR data element) will be accepted and stored as is.

The SCP will match the received Storage SOP instances to patients and studies in the PathSpeed™ PACS database via Study Profiling procedure. The Study Profiling behavior of the SCP depends on the called AE Title that the remote AE selected to request the association, see Sections 4.2.1 and 4.2.2.

Note: The Study Profiling procedure can cause changes of certain data elements in the SOP Instances. PathSpeed™ PACS does not regenerate a new SOP instance for the data coercion. A remote AE may receive the same SOP instance with certain data elements changed at a later time. A list of data elements that may be corrected, as well as the correction reasons are given in Section 4.2.3

The Study Profiling procedure has been designed to optimize its performance when a remote AE sends all SOP Instances of a study in one association (regardless of the image order in series and the series order in study). This is, however, not a required condition. The SCP is able to handle any form and any order of SOP Instances transmission either in one single association or in multiple association. But the performance of the SCP (because the AE operation is synchronized with the Study Profiling procedure) will not be optimum.

As part of the Study Profiling procedure, the Storage AE can change the status of study for the last received image to “verified” when the calling AE (SCU) closes an association. This behavior is controlled by the called AE Title selected by the remote AE. See Section 4.2.2 for more information.

Note: When a study is “verified” in PathSpeed™ PACS, it cannot receive any more images and the study can be read by a radiologist. The SOP Instances sent to a “verified” study (including additional new images or re-transmission of old images) will be either rejected or placed to a newly created study, depending on the called AE Title of the Storage AE receiving the instances (Section 4.2.2)

The SCP can validate the received SOP Instances against the DICOM v3.0 Standards for data integrity. This feature can be configured as turned-on or -off (see Section 2.6.6)

The SCP will ignore the value of the C-STORE priority attribute.

If the SCP accepts a received SOP Instance for storage, the instance is stored in the file format as specified in DICOM PS 3.10-1999, with the Explicit VR Big Endian transfer syntax. The SCP will store all unknown data elements as “unknown VR (UN)”. Therefore, besides the data change / correction mentioned above, certain data elements may be recomputed for the sake of the data storage, like group length, sequence length, etc.

If any of timers (see Section 2.3.1.5) expires, the connection is closed and the operation in progress is considered failed.

The SCP will abort the association with an A-ABORT when processing of Store Requests cannot be completed because the PathSpeed™ PACS storage or database subsystem is not functioning (see Section 4.1.2.3.4).

4.1.2.3.2 Storage of SOP Instance Data Elements in Database

After having matched a SOP instance to the Patient / Study in the PathSpeed™ PACS database via the Study Profiling procedure (see Sections 4.2.1 and 4.2.2), certain data elements of the Storage SOP instance are saved in the database. The data elements saved in the PathSpeed™ database may be subject to data coercion due to the Study Profiling procedure or Patient / Study update either by information received from RIS or manually performed by the PathSpeed™ Exam Manager operator.

In addition, some data fields of PathSpeed™ database have a smaller size than the size specified in the DICOM Standard. Any data values exceeding the field size of the database will be truncated:

Data Element	DICOM Size	Database Size	Behavior
Patient ID	64 Char	32 Char	The characters exceeding the size allowed by the database will be truncated. No warning returned to the SCU.
Patient Name*	64 Char	40 Char	The Patient Name will be first converted to the database format (see Section 4.2.1) and then truncated if the size exceeds the size allowed by the database. No warning returned to the SCU.

TABLE 4-2: DATA ELEMENTS MAY BE TRUNCATED IN THE DATABASE

*: This restriction applied to the Alphabetic Name group if the Patient Name data element in a received data set is multi-valued. An UTF-8 text string up to 255 bytes in the PathSpeed™ database is

supported for both the Ideographic and Phonetic Name groups. This guarantees that these name groups are not truncated.

4.1.2.3.3 SOP Instance Storage and Abnormal Association Termination

4.1.2.3.3.1 Data Caching

The SCP can cache several SOP instances locally in memory during the receipt operation. After each SOP instance is received, the SCP will acknowledge the receipt of the instance with a C-STORE response but may not necessarily write it already to the PathSpeed™ PACS storage system.

Received SOP instances are always written to the PathSpeed™ PACS storage system when any of the following conditions are met:

1. The association is closed because
 - the SCU requested Association Release
 - any time-out of the association is expired (see Section 2.3.1.5)
 - the operator properly shuts down the SCP
2. A SOP instance for a different study is received. All SOP instances cached for the previous study will be written to the PathSpeed™ PACS storage system.
3. The SCP data cache becomes full.

4.1.2.3.3.2 SOP Instance Storage by SCP

It is possible for the SCP to fail in a manner where the cached data is unrecoverable, such as a power failure. The SCU use the following rules to decide if the transmitted SOP Instances have been stored safely in PathSpeed™ PACS:

- If the SCU requested association release (A-RELEASE) and received A-RELEASE response from the SCP, all successfully transmitted SOP Instances (messages) in the association have been stored in the PathSpeed™ on-line storage system persistently.
- If the SCU issues an association abort (A-ABORT) or receives a provider-initiated abort (A-P-ABORT), the success or failure of the Storage SCP to retain any object sent on the association is undefined.
- If an association is terminated because of any network operation failure or time-out, the success or failure of the Storage SCP to retain any object sent on the association is undefined.

The Storage SCU is strongly recommended to use the DICOM Storage Commitment service to verify the permanent storage status of the submitted SOP instances (see Section 6).

4.1.2.3.4 C-STORE Response Status

The Storage SCP will return the following status codes in C-STORE-RSP message:

Service Status	Status Code	Further Meaning	Status Code Sending Explanation	Related Fields Send Back to SCU
Success	0000	Image Accepted	Image successfully profiled to a Study object in the PathSpeed™ database.	None
Refused	A700	Out of Resource	Processing of Store Requests cannot be completed because the PathSpeed™ PACS storage or database subsystem is not functioning.	None
Error	A900	Cannot Understand	Following generally required data elements in the SOP instance missed: SOP Instance UID SOP Class UID Study Instance UID Series Instance UID	None
	C000	Cannot Understand	Processing of Store Requests cannot be completed because the failure of Study Profiling (e.g., no match found and the called AE Title is unable to create new Patient / Study.).	None

TABLE 4-3: STATUS CODES RETURNED IN C-STORE-RSP

If a status code of Refused or Error is returned in a C-STORE-RSP, the success or failure of the SCP to retain the SOP Instance transmitted in the corresponding C-STORE-RQ is undefined.

4.1.3 Extended Character Sets

The use of extended character sets is fully supported. A received SOP Instance can be stored, archived and retrieved with all text information encoded with any supported character sets.

When adding the text information from the received data set to the PathSpeed™ database, however, only the Patient Name data element is supported for all character sets listed in Section 2.7. Other text information will not be added to the database if they are encoded with any character set other than ISO-IR-6 or ISO-IR-100 (but these text strings still remain in the data sets, which are stored and archived).

4.2 IMPORTANT REMARKS TO STORAGE AE (SCP ROLE)

4.2.1 Study Profiling

The Storage AE will perform the Study Profiling process for each received Storage SOP Instance, in order to relate it to an ordered study object in the PathSpeed™ database. The process is performed by matching the Patient / Study level data elements in the data set of the SOP instance to the Patient / Study object existing in the database.

Note: A comprehensive description of the Study Profiling process is beyond the scope of this document. See product documents of PathSpeed™ PACS for more information.

4.2.1.1 Data Elements Applied for Patient / Study Matching

Table 4-4 lists the data elements of a SOP instance used to match it to a study (of a patient) in the PathSpeed™ PACS database.

Attribute Name	Tag
Patient's Name	(0010,0010)
Patient ID	(0010,0020)
Patient Birth Date	(0010,0030)
Patient Sex	(0010,0040)
Accession Number	(0008,0050)
Study Instance UID	(0020,000D)
Study ID	(0020,0010)
Study Date	(0008,0020)
Study Time	(0008,0030)
Modality	(0008,0060)

TABLE 4-4: DATA ELEMENTS USED IN STUDY PROFILING

Not all of these data elements are always used for a Study Profiling process. The Storage AE supports a number of separate AE Titles, which choose a subset of these data elements for a particular Study Profiling algorithm. Section 4.2.2 gives these AE Titles along with other properties of a Study Profiling process, like the ability of creating a new study if a matching to the existing studies failed.

4.2.1.2 Extended Character Sets in Patient Name Text Encoding

If the Patient Name data element in a received data set is multi-valued, only the Alphabetic Name group is applied for the patient / study matching. Other name groups are ignored for the data matching purpose. If the Alphabetic Name is absent but other name groups exist, the data set is treated as if the patient name is a null length value in terms of patient / study matching.

If the Alphabetic Name is provided with character set ISO-IR-13, a transliteration process is applied to convert it into the representation of ISO-IR-6. The transliteration is performed according to the Table-II specification in the Japanese Dictionaries.

4.2.1.3 Patient Name Format Conversion

Before the data elements of a SOP instance are used to search for or create data in the PathSpeed™ PACS Database, Patient Names supplied by the calling AE (Store SCU) are first converted to upper case. They are then translated from DICOM format to the normal format used in reading worklists. For example, the DICOM formatted name "Last^First^Middle^Prefix^Suffix" becomes "LAST, FIRST MIDDLE PREFIX SUFFIX".

Notice that a comma has been added between the first and last names specified in the DICOM format. If a complete DICOM name comes in with no separators (^), then no comma is added to the name. In this case, the DICOM formatted name "Last First Middle Prefix Suffix" becomes "LAST FIRST MIDDLE PREFIX SUFFIX".

Note: The Person Name Conversion is performed only in the PathSpeed™ database. This does not affect the format of the person name in the DICOM data set of the SOP Instances stored and archived in the PathSpeed™ PACS.

In the PathSpeed™ database, a Patient Name complex is separated with the Last Name and the Rest Name including First Name, Middle Name, Prefix and Suffix, and the comma ',' is used as delimiter.

As described in Section 4.1.2.3.2, the Patient Name string will be truncated if it exceeds the allowed size (Table 4-2).

4.2.1.4 Verified and Canceled Study

If a study matched by the Study Profiling process has a (PACS internal) status "verified" or "canceled", no more SOP Instances can be added to it. This will cause the Storage AE either to reject the received SOP Instance, or to create a new (unordered) study to host the SOP Instance, depending on the capability of the called AE Title, see Section 4.2.2.

The solution for this problem is to "un-verify" the study if it is "verified", or to recover the study if it is "canceled", prior to sending the SOP Instances to the study. See PathSpeed™ PACS product documents for more information about these operations.

4.2.2 Behavior of AE Title Selected by SCU

A number of AE Titles can be configured for the Storage AE to support different algorithms for the Study Profiling of the received SOP Instances.

The PathSpeed™ PACS system allows selection of the following elements to configure a Study Profiling algorithm (a Storage AE Title):

- A number of DICOM data elements listed in Table 4-4
- The database fields that the DICOM data elements should be mapped to
- A comparison operation used to match the DICOM data elements to the database fields, e.g., simple match, wildcard matching, etc.

The specified Storage AE Title will use the defined algorithm to perform the Study Profiling process for all images sent to it.

In addition to specify the matching elements for the Study Profiling algorithm, the following features can be defined for the specific Storage AEs, too:

1. Patient / Exam Creation Ability. If the matching defined the Study Profiling algorithm failed or the matched exam is already “verified”, a new patient and / or (unordered) study can be created in the PathSpeed™ database to host these unmatched images. Disabling the Patient / Exam Creation ability causes the images to be rejected if the matching failed. If this ability is enabled, the Storage AE will use the data elements in the DICOM header of the received images to create the patient and / or exam objects.
2. Automatic Study Verification. The automatic study verification refers to the ability to change the status of a study to “verified” after successful completion of one DICOM association, if the study receives one or several SOP instances in the association. The study states are defined interior the PathSpeed™ PACS system. When a study is “verified” in the PathSpeed™ PACS database, no more Storage SOP instances may be placed into the study.

Using different Study Profiling algorithms via different AE Titles is mainly to help coping with different behaviors of the imaging modalities to get the patient / study data entered and therefore to include these data items in the generated SOP instances.

The ability of configuring the specific Storage AE Titles refers to the Dynamic Profiling function of PathSpeed™ PACS. See product documents of PathSpeed™ PACS for more information.

4.2.3 Coercion of Data Elements

PathSpeed™ PACS supports an interface to customer HIS/RIS systems or use PathSpeed™ Exam Manager to perform necessary RIS functions. The RIS information is always assumed by PathSpeed™ PACS (either a real RIS or PathSpeed™ Exam Manager) to contain the more accurate Patient and Study data than the data received from the acquisition systems via DICOM Composite SOP Instances. Therefore, the RIS information is always used to correct any data entry errors. This data error correction is propagated to all DICOM Storage SOP Instances maintained in PathSpeed™ PACS.

Another reason causing the change of the data elements in the SOP Instances is the Study Profiling. As long as a SOP Instance is matched to an existing study in the PathSpeed™ database, all data attributes of the study (as well as its upper-associated Patient) are propagated to the SOP Instance. This is because the Storage AE more trusts the “RIS data”.

Also the Study Instance UID, Series Instance UID and SOP Instance UID can be changed, if they conflict with the UID values already used in the PathSpeed™ database to identify another (Study, Series or SOP Instance) object.

The following table lists all data elements of the SOP Instances that may undergo a data correction in PathSpeed™ PACS. They can be different from the original values when a remote AE retrieves them from the Q/R AE of the DICOM Server.

Attribute Name	Tag	Change Reason
Patient ID	(0010,0020)	SOP Instance is associated to another patient, or wrong Patient ID is included in the data set
Patient's Name*	(0010,0010)	Wrong data in data set. Most likely manual input.
Patient's Birth Date	(0010,0030)	Wrong data in data set. Most likely manual input.
Patient's Sex	(0010,0040)	Wrong data in data set. Most likely manual input.
Other Patient Ids	(0010,1000)	Data corrected or supplemented
Study Instance UID**	(0020,000D)	SOP Instance is associated to another study
Accession Number	(0008,0050)	Wrong data in data set. Most likely manual input.
Study Date	(0008,0020)	Study with multiple steps performed on different device, PathSpeed™ PACS takes the earliest study date / time.
Study Time	(0008,0030)	See above.
Referring Physician's Name	(0008,0090)	Wrong data in data set. Most likely manual input.
Study Description	(0008,1030)	Study with multiple steps performed on different device, PathSpeed™ PACS can only take one.
Requested Procedure ID	(0040,1001)	Data corrected or supplemented
Series Instance UID**	(0020,000E)	Bad Series Instance UID in the data set
Series Number	(0020,0011)	User specific reasons.
SOP Instance UID**	(0008,0018)	Bad SOP Instance UID in the data set
Image Number	(0020,0013)	User specific reasons.
Number of Images in Acquisition	(0020,1002)	User specific reasons.

TABLE 4-5: DATA ELEMENT COERCION OF THE SOP INSTANCES

*: Patient Name may be multi-valued and encoded with extended character sets, see Section 3.1.3.

** : If these UID values are changed, the original UID values are saved in the data set as private tags, see Appendix B.

4.2.4 Supported Uses of SOP Instances

Usually, PathSpeed™ PACS is applied in the radiology practice for image data management, storage, archiving, display, print, and distribution.

The DICOM Conformance Statement information specifies which DICOM Storage SOP Classes are supported by the PathSpeed™ DICOM Server as SCP, i.e., they can be received by PathSpeed™ PACS. This does not automatically confirms that all SOP Instances can be displayed or printed or processed in certain application.

This section gives the information of the supported uses of the received SOP Instances in PathSpeed™ PACS.

4.2.4.1 Data Storage

PathSpeed™ PACS will store all successfully received SOP Instances in its on-line storage subsystem.

4.2.4.2 Data Archiving

PathSpeed™ PACS will archive all successfully received SOP Instances in its long-term archiving subsystem. The storage duration in the long-term archiving subsystem is permanent.

Note: Although a permanent storage function is always provided for the received SOP Instances, a remote AE is strongly recommended to use the DICOM Storage Commitment - PUSH Model SOP class to verify the archiving status of the submitted SOP Instances.

4.2.4.3 Information Query and Data Retrieval

PathSpeed™ PACS supports a remote AE to query the information and to retrieve the data sets of all stored and archived SOP Instances, using the DICOM Query / Retrieve SOP Classes.

PathSpeed™ PACS performs an information query always against the data maintained in the database.

PathSpeed™ PACS performs a data retrieval always against both the on-line storage subsystems and the long-term archiving subsystems.

Note: A remote AE may be unable to query and retrieve the SOP Instances using the original values in certain matching keys as sent to PathSpeed™ PACS previously, because of the data coercion, see Section 4.2.3.

4.2.4.4 Data Display

PathSpeed™ Workstation and PathSpeed™ WEB Clients are able to display an image SOP Instance if it meets the following conditions:

Modality Code	(0008,0060)	The image SOP Instance must contain one of the following modality code: <ul style="list-style-type: none"> •CR •CT •MR •RG •DS •DF •XA •RF •DX •PT •US •NM •MG*
Photometric Interpretation	(0028,0024)	The image SOP Instance must contain one of the following Photometric Interpretation values: <ul style="list-style-type: none"> •MONOCHROME1 •MONOCHROME2 •RGB •YBR_FULL** •YBR_FULL_422**

TABLE 4-6: CONDITIONS FOR IMAGE SOP INSTANCE DISPLAY

*: PathSpeed™ PACS supports the display of digital mammograms (modality code: MG) only for secondary review purposes (not for primary diagnosis).

** : PathSpeed WEB Clients are able to display the YBR_FULL and YBR_FULL_422 color images only if these are sent to the PathSpeed PACS using the DICOM JPEG Baseline transfer syntax.

PathSpeed™ PACS is unable to display any non-Image SOP Instance, e.g., curves.

4.2.4.5 DICOM Data Element List

PathSpeed™ Workstation and PathSpeed™ WEB Clients are able to display a list of data elements in an image SOP Instance. All data elements with a group number less than 0x7FE0 can be listed.

Text information encoded with any character sets listed in Section 2.7 can be displayed, provided that the PathSpeed™ Workstation or PathSpeed™ WEB Clients platform is appropriately configured. For the requirements for the platform configuration, see PathSpeed™ PACS documentation.

4.2.4.6 Data Print

PathSpeed™ Print Server is able to print an image SOP Instance if it meets the following conditions:

Modality Code	(0008,0060)	The image SOP Instance must contain one of the following modality code: <ul style="list-style-type: none"> •CR •CT •MR •RG •DS •DF •XA •RF •DX •PT •US •NM •MG
Photometric Interpretation	(0028,0024)	The image SOP Instance must contain one of the following Photometric Interpretation values: <ul style="list-style-type: none"> •MONOCHROME1 •MONOCHROME2 •RGB* •YBR_FULL* •YBR_FULL_422*

TABLE 4-7: CONDITIONS FOR IMAGE SOP INSTANCE PRINT

**: The color images are converted to a grayscale representation by extracting the brightness component, and printed on a grayscale printer. PathSpeed™ PACS does not support color printers.*

PathSpeed™ PACS is unable to print any non-image SOP Instance, e.g., curve.

5. DICOM QUERY / RETRIEVE SERVICE CONFORMANCE STATEMENT

This section describes the conformance statement for information query and data retrieval functions supported in PathSpeed™ PACS. They are implemented in the Q/R AE as the SCP role of the DICOM Query / Retrieve SOP Classes.

5.1 DICOM QUERY REQUEST FROM REMOTE AE

The Q/R AE constantly listens for incoming associations to serve a DICOM Query request from a remote AE.

The Q/R AE is able to accept multiple DICOM associations simultaneously. The maximum number of the concurrent associations that the Q/R AE can accept for serving DICOM Query requests, is configurable (see Section 2.6.2 and Table 2-4).

5.1.1 Associated Real-World Activity

The following real-world activities are associated with the C-FIND service element (response role) (refer to Figure 2-3):

1. Search for patients, studies, series, or SOP instances in the PathSpeed™ PACS database
2. Send the found data sets in C-FIND responses to the remote AE

5.1.2 Accepted Presentation Context

The following table shows the presentation contexts accepted by the Q/R AE:

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
SOP Class	UID	Name List	UID List		
Patient Root Q/R Information Model – FIND	1.2.840.10008.5.1.4.1.2.1.1	Explicit VR Big Endian	1.2.840.10008.1.2.2	SCP	None
Study Root Q/R Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1			SCP	None
Patient Root Q/R Information Model – MOVE	1.2.840.10008.5.1.4.1.2.1.2	Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
Study Root Q/R Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2			SCP	None
Verification (DICOM Echo)	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

TABLE 5-1: ACCEPTABLE PRESENTATION CONTEXT FOR DICOM QUERY

The columns Transfer Syntax in Table 5-1 lists all transfer syntaxes that the Q/R AE can accept the presentation contexts for the DICOM Q/R Information Models. The DICOM Server can be configured to accept one or several or all of these transfer syntaxes.

5.1.2.1 SOP Specific Conformance Statement for Verification Service Class

The Q/R AE provides standard conformance to the DICOM Verification Service Class as SCP.

5.1.2.2 SOP Specific Conformance Statement for Query / Retrieve Information Model – FIND SOP Classes

The Q/R AE provides standard conformance to the DICOM Query / Retrieve Information Model – FIND SOP Classes as SCP.

5.1.2.2.1 General Behavior

The SCP uses the DIMSE service element C-FIND to serve a DICOM query from a remote AE as follows:

1. The Q/R AE supports a DICOM Query at all levels of Patient / Study / Series / SOP Instance as specified in the supported DICOM Query / Retrieve Information Models (Table 5-1), and return the found data sets in C-FIND response.
2. The Q/R AE only uses the keys of supported type matching (see Sections 5.1.2.2.4 and 5.1.2.2.5) to perform the database search. Values in keys of type Returned will be ignored and will be filled in with data found from the database.
3. Any unsupported key (not included in Sections 5.1.2.2.4 and 5.1.2.2.5) will be ignored. No corresponding data element will be returned at all.
4. Sequence matching is supported by the Q/R AE.
5. Range matching is supported for the Date and Time keys (see Section 5.1.2.2.3)
6. The Q/R AE only supports hierarchical query. No relational query is supported.
7. The Q/R AE searches for the data set using the matching keys specified in the C-FIND request against the PathSpeed™ database.
8. The Q/R AE does not provide any value for the data element Storage Media File-Set ID. At the moment, the PathSpeed™ PACS system does not support any DICOM Media Storage SOP class.
9. The Q/R AE will ignore the data element Priority in a DICOM Query request.

Note: Due to the data coercion of the SOP Instances as described in Section 4.2.3, the return data elements can be different from the values in the DICOM Storage SOP Instances originally sent to the Storage AE.

5.1.2.2.2 Data Query to PathSpeed™ PACS Database

When a query specifies a searching key for a person name, the Q/R AE will perform an automatic data conversion. The Q/R AE converts the DICOM person name format to the person name format used in the PathSpeed™ database as specified in Section 4.2.1.3, and forces a case-insensitive search in the database.

The Q/R AE reserves the right to reject any query which would cause extremely large compute or I/O intensive operations during the search such as a query matching all studies in the database.

In general, the Q/R AE will always return a limited number of responses to a Q/R SCU, if the submitted query may potentially generate a large number of matches in the database. The maximum number of returned query responses is configurable.

5.1.2.2.3 Matching Operations

5.1.2.2.3.1 Date and Time Keys Matching Operations

The Q/R AE supports a DICOM Query request using any matching operations in a date or time matching key specified in the DICOM PS 3.4-1999, as listed in the following table:

SPEC.	Key Value Description
NONE	No key or no key value was specified
EQ	<value> ; match all occurrences of value
GE	<value>- ; match all occurrences of value and subsequent values
LE	-<value> ; match all occurrences of prior to and including value
RANGE	<value1>-<value2> ; match all occurrences between value1 and value2 inclusive.

TABLE 5-2: DATE AND TIME MATCHING OPERATIONS

Because PathSpeed™ PACS saves the date and time values in one single field in the database, an arbitrarily independent search for the date and time keys in a DICOM Query request cannot be supported. For a combination of the date and time matching keys, the Q/R AE will interpret the performed date and time joint matching as indicated in Table 5-3.

Date Specification See Table 5-2	Time Specification See Table 5-2	Operation Performed
NONE	NONE, EQ, GE, LE, RANGE	Search not qualified by date and time (ignored)
EQ, GE, LE, RANGE	NONE	Search using date specification
EQ	EQ, GE, LE, RANGE	Search using specified date and time
GE, LE, RANGE	EQ, GE, LE, RANGE	Search using date specification only

TABLE 5-3: DATE AND TIME JOINT MATCHING OPERATIONS PERFORMED BY THE SCP

5.1.2.2.3.2 Other Keys Matching Operations

The Q/R AE supports single value matching for all keys of a supported type “Matching”, see Section 5.1.2.2.4.

The Q/R AE supports wild card matching for all text valued keys of a supported type “Matching”, see Section 5.1.2.2.4.

The Q/R AE supports UID list matching for all UID keys of a supported type “Matching”, see Section 5.1.2.2.4.

5.1.2.2.4 Patient Root Information Model Definition

This section specifies the use of the DICOM Patient Root Query / Retrieve Information Model for matching keys and returned keys supported in a DICOM Query request.

Sections 5.1.2.2.4.1 through 5.1.2.2.4.4 define what attributes are supported for query. The following usage definitions are specified for each attribute:

Usage	Description of Term
Matching	Matching is supported, and values for it are returned
Partial Matching	Partial matching is supported. Explanations will be given on a per key basis.
Returned	If the attribute is sent in the request, then if a value exists in the database it will be returned. No matching is performed

TABLE 5-4: QUERY KEY USAGE

5.1.2.2.4.1 Patient Level Key Attributes Supported

Description	Tag	Usage
Patient's Name*	(0010,0010)	Matching
Patient ID	(0010,0020)	Matching
Patient's Birth Date	(0010,0030)	Returned
Patient's Sex	(0010,0040)	Returned
Other Patient Ids	(0010,1000)	Returned
Ethnic Group	(0010,2160)	Returned

TABLE 5-5: PATIENT LEVEL KEY ATTRIBUTES

*: The Q/R AE accepts a multi-valued Patient Name data element as a matching key, if the Alphabetic Name is fully qualified. If the Alphabetic Name is partially qualified, only a single-valued Patient Name element can be used as a matching key.

5.1.2.2.4.2 Study Level Key Attributes Supported

Description	Tag	Usage
Study Instance UID	(0020,000D)	Matching
Accession Number	(0008,0050)	Matching
Study ID	(0020,0010)	Matching
Study Date	(0008,0020)	Matching See Section 5.1.2.2.3
Study Time	(0008,0030)	Partial Support See Section 5.1.2.2.3
Referring Physician's Name	(0008,0090)	Returned
Study Description	(0008,1030)	Returned
Procedure Code Sequence	(0008,1032)	Matching
>Code Value	(0008,0100)	Matching
>Coding Scheme Designator	(0008,0102)	Matching
>Code Meaning	(0008,0104)	Matching

TABLE 5-6: STUDY LEVEL KEY ATTRIBUTES

5.1.2.2.4.3 Series Level Key Attributes Supported

Description	Tag	Usage
Modality	(0008,0060)	Matching
Series Number	(0020,0011)	Matching
Series Instance UID	(0020,000E)	Matching
Series Description	(0008,103E)	Returned
Body Part Examined	(0018,0015)	Matching

TABLE 5-7: SERIES LEVEL KEY ATTRIBUTES

5.1.2.2.4.4 SOP Instance Level Key Attributes Supported

Description	Tag	Usage
Instance Number	(0020,0013)	Matching
SOP Instance UID	(0008,0018)	Matching

TABLE 5-8: SOP INSTANCE LEVEL KEY ATTRIBUTES

5.1.2.2.5 Study Root Information Model Definition

The study level key attributes supported are the same as those listed in Section 5.1.2.2.4.1 and Section 5.1.2.2.4.2.

The series level key attributes supported are the same as those listed in Section 5.1.2.2.4.3.

The SOP instance level key attributes supported are the same as those listed in Section 5.1.2.2.4.4.

5.1.3 Extended Character Sets

The Q/R AE may include a multi-valued Patient Name element in the query responses, if the query requesting AE has been configured to intend to receive the multi-valued names and these are available in PathSpeed™ database. While the Alphabetic Name is always encoded with ISO-IR-8859-1 character sets, the Ideographic and Phonetic Names can be encoded with other dual-byte character sets as listed in Section 2.7. In the current release, the Q/R AE will not include text information encoded with extended character sets in any other data elements of the query responses.

See PathSpeed™ service documentation for the peer AE configuration method.

5.2 DICOM RETRIEVE REQUEST FROM REMOTE AE

The Q/R AE constantly listens for incoming associations to serve a DIMSE C-MOVE operation issued from a remote AE.

The Q/R AE accepts associations for finding the SOP Instances and send the found SOP Instances to the destination AE specified in the C-MOVE operation, as Query / Retrieve SCP.

The Q/R AE initiates associations in response to requests to move images, as DICOM Store SCU.

The Q/R AE is able to accept multiple DICOM associations simultaneously. The maximum number of the concurrent associations that the Q/R AE can accept for serving DICOM Retrieve requests, is configurable.

5.2.1 Associated Real-World Activity

The following real-world activities are associated with the C-MOVE service element (response role) (refer to Figure 3-1):

1. Search for the information of the requested SOP Instances in the PathSpeed™ database and gain the access to the data files of the SOP Instances.
2. Send found SOP Instances to the specified remote AE specified in the DICOM Retrieve request, if the data files are accessible.
3. Send C-MOVE-RSP to the calling remote AE.

5.2.2 Accepted Presentation Context

See Table 5-1 in Section 5.1.2.

As shown in Table 5-1, the Q/R AE supports all three non-compression DICOM standard transfer syntaxes. For each abstract syntax, however, the Q/R AE only accepts one presentation context according to the transfer syntax selection rules in section 2.3.3.

5.2.2.1 SOP Specific Conformance Statement for Query / Retrieve Information Model – MOVE SOP Classes

The Q/R AE provides standard conformance to the DICOM Query / Retrieve Information Model – MOVE SOP Classes as SCP.

1. The Q/R AE searches for the requested SOP Instances in PathSpeed™ database as specified by the Unique Key values in C-MOVE-RQ. If no requested SOP instances can be found then the Q/R AE will return C-MOVE-RSP to the calling AE with a status Success. The response will equal zero for the number of completed, failed, and warning sub-operations.
2. All SOP Instances requested in a C-MOVE-RQ will be sent to the destination AE over a single association. The Q/R AE sends a C-MOVE-RSP with the Pending status to the SCU periodically with a configurable time interval.
3. A C-MOVE-RSP will contain the number remaining, completed, failed, and warning C-STORE sub-operations.
4. The Q/R AE will ignore the data element Priority, if it is included in the C-MOVE request.

5.2.3 Proposed Presentation Context

The Q/R AE initiates a DICOM association to the data move destination AE to perform the DIMSE C-STORE operation for sending the found SOP Instances.

The Q/R provides the exact same Conformance Statement for this DICOM Storage SCU Role as described in Section 3.1, (page 3–25).

Note: Due to the data coercion of the SOP Instances as described in Section 4.2.3, the retrieved SOP Instances can contain certain data elements with different values from the SOP Instances sent to PathSpeed™ PACS originally.

5.2.4 Extended Character Sets

The Q/R AE may perform a data coercion in a SOP Instance sent to the data retrieval requesting AE, in order to update the data set with the information maintained in the PathSpeed™ database. The Patient Name (0010,0010) may be multi-valued to include Ideographic and Phonetic name groups in addition to Alphabetic Name. This will be done if the receiving AE has been configured to intend to receive these additional names and these are available in PathSpeed™ database. While the Alphabetic Name is always encoded with ISO-IR-8859-1 character sets, the Ideographic and Phonetic Names can be encoded with other dual-byte character sets as listed in Section 2.7. In the current release, the DICOM Server will not add text information encoded with extended character sets into other data elements.

See PathSpeed™ service documentation for the peer AE configuration method.

6. DICOM STORAGE COMMITMENT SERVICE CONFORMANCE STATEMENT

This section describes the conformance statement for the storage commitment functions supported in PathSpeed™ PACS. They are implemented in the Storage AE as the SCP role of the DICOM Storage Commitment SOP Classes.

6.1 RECEIVE STORAGE COMMITMENT REQUEST FROM REMOTE AE

The Storage AE constantly listens for incoming associations to receiving a Storage Commitment request (as well as DICOM Storage SOP Instances) from a remote AE.

The Storage AE is able to accept a presentation context for the Storage Commitment – PUSH Model SOP Class either in a dedicated association, or in a single association together with presentation contexts for DICOM Storage SOP Classes. The behavior of the Storage AE with respect to the Storage Commitment service is the same in the both cases.

The Storage AE is able to serve multiple DICOM associations simultaneously. The maximum number of the concurrent associations that the Storage AE can accept is configurable (see Section 2.6.2 and Table 2-4).

6.1.1 Associated Real-World Activity

The following real-world activities are associated with the Receive Storage Commitment Request operation (refer to Figure 2-2):

1. The Storage AE places a job (transaction) in the PathSpeed™ Storage Commitment Queue. The job includes all SOP instances requested for storage commitment, as well as the calling DICOM AE Title. For each job, a timer is started when it is added to the Storage Commitment Queue.
2. The Storage AE constantly polls the queue for a job which response can be sent back to the original requester.

Note: Other components of PathSpeed™ PACS will process the Storage Commitment Queue and update the status of the Jobs (pending or completed or failed or time-out). This is beyond the scope of this conformance statement document.

6.1.2 Accepted Presentation Context

See Table 4-1 in Section 4.1.2.

As shown in Table 4-1, the Storage AE can accept any of the three transfer syntaxes listed for the abstract syntax DICOM Storage Commitment - PUSH SOP Class. The DICOM Server can be configured to accept the presentation syntaxes with one or several or all of these transfer syntaxes.

6.1.2.1 SOP Specific Conformance Statement for Storage Commitment - Push Model SOP Class

The Storage AE provide standard conformance to the DICOM Storage Commitment Service as SCP. The Storage AE uses the DIMSE service element N-ACTION to receive a Storage Commitment request.

The Storage AE supports the following data elements in the part of data set in a received N-ACTION request:

Data Element	Tag	Description
Transaction UID	(0008,1195)	UID to identify this request
Referenced SOP Sequence	(0008,1199)	A list of SOP instance to be requested for storage commitment
> Referenced SOP Class UID	(0008,1150)	SOP Class UID of the instance
> Referenced SOP Instance UID	(0008,1155)	SOP Instance UID of the instance

TABLE 6-1: DATA ELEMENTS SUPPORTED IN STORAGE COMMITMENT REQUEST

The Storage AE will ignore the following data elements if they are included in a Storage Commitment request.

Data Element	Tag	Description
Storage Media File-Set ID	(0088,0130)	The DICOM File-Set from that all SOP instances can be retrieved.
Storage Media File-Set UID	(0088,0140)	
Referenced Study Component Sequence	(0008,1111)	The Study Component that contains all SOP instances listed in the referenced SOP sequence.

TABLE 6-2: DATA ELEMENTS IGNORED IN STORAGE COMMITMENT REQUEST

The Storage AE will accept a Storage Commitment request for both referenced SOP Instances already received (known objects) and not yet received at this moment (unknown objects). If the unknown objects are received and archived successfully at a later time (before the Storage Commitment jog timer expires), a success response will be sent to the requester.

The Storage AE will return a Success Status Code in N-ACTION-RSP to indicate that the Storage Commitment transaction is received successfully and queued in PathSpeed™ PACS for processing. A Storage Commitment response will be sent to the remote AE via N-EVENT-REPORT operation.

The Storage AE will return a Failure Status Code in N-ACTION-RSP to indicate that the receipt of the Storage Commitment transaction failed or the transaction cannot be processed. No Storage Commitment response will be sent to the remote AE.

6.1.2.2 N-ACTION Response Status

The Storage AE will return the standard status codes in N-ACTION-RSP message as specified in DICOM PS 3.7-1999.

6.2 SEND STORAGE COMMITMENT RESPONSE TO REMOTE AE

The Storage AE initiates a DICOM association to send DICOM Storage Commitment response to a remote AE, in respond to a previously received Storage Commitment transaction.

The Storage AE will always initiate a new DICOM association to send DICOM Storage Commitment responses. It will never send DICOM Storage Commitment responses in the same DICOM association, in that a DICOM Storage Commitment request is received.

The Storage AE will always initiate one single DICOM associations for sending the Storage Commitment report simultaneously. Multiple Storage Commitment reports will be sent subsequently.

6.2.1 Associated Real-World Activity

The following real-world activity will cause that the Storage AE to initiate a DICOM association for sending DICOM Storage Commitment:

1. The Storage AE polls periodically the PathSpeed™ Storage Commitment Queue and gets a job, which is pending, completed, or time-out.

6.2.2 Proposed Presentation Context

The Storage AE will propose the following presentation context to send Storage Commitment response to a remote AE.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
SOP Class	UID	Name List	UID List		
Storage Commitment - Push Model	1.2.840.10008.1.20.1	Explicit VR Big Endian	1.2.840.10008.1.2.2	SCP	SCU/SCP Role Selection
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Implicit VR Little Endian	1.2.840.10008.1.2		

TABLE 6-3: PROPOSED PRESENTATION CONTEXT FOR STORAGE COMMITMENT REPORT

The columns Transfer Syntaxes in Table 6-3 lists all transfer syntaxes that the Storage AE can propose for the abstract syntax Storage Commitment - PUSH Model SOP Class. The DICOM Server can be configured to propose the presentation contexts with one or several or all of these transfer syntaxes.

The Storage AE will propose SCU/SCP Role Selection negotiation for the presentation contexts of the Storage Commitment - PUSH Model SOP Class.

6.2.2.1 SOP Specific Conformance Statement for Storage Commitment - PUSH Model SOP Class

The Storage AE will invoke the N-EVENT-REPORT operation in the established association to send Storage Commitment response to the remote AE, in respond to a previously received Storage Commitment transaction.

The Storage AE can send one or more Storage Commitment responses over a single association.

The Storage AE always initiates a separate, dedicated association to send Storage Commitment responses. It will never send Storage Commitment responses over the same association that a Storage Commitment request is received.

The Storage AE will use the Event Type ID value 1 to send a Success Storage Commitment response, and include the following data elements in the data part of N-EVENT-REPORT-RQ:

Data Element	Tag	Description
Transaction UID	(0008,1195)	UID to identify this Storage Commitment transaction to respond
Referenced SOP Sequence	(0008,1199)	A list of SOP instances to be committed for long-term archiving in PathSpeed™ PACS. This sequence should match the requested sequence in the corresponding Storage Commitment request.
> Referenced SOP Class UID	(0008,1150)	SOP Class UID of the instance
> Referenced SOP Instance UID	(0008,1155)	SOP Instance UID of the instance

TABLE 6-4: DATA ELEMENTS INCLUDED IN SUCCESS STORAGE COMMITMENT RESPONSE

PathSpeed™ PACS guarantees a long-term archiving of the committed SOP Instances. A remote AE can retrieve the SOP Instance from PathSpeed™ PACS via the Q/R AE of the DICOM Server.

Note: Due to the data coercion of the SOP Instances as described in Section 4.2.3, the SOP Instance UID of an object may be altered. In this case, PathSpeed™ PACS is unable send a success response to the Storage Commitment request, even if the altered object has been successfully archived.

The Storage AE will use the Event Type ID value 2 to send a Failure Storage Commitment response, and include the following data elements in the data part of N-EVENT-REPORT-RQ:

Data Element	Tag	Description
Transaction UID	(0008,1195)	UID to identify this Storage Commitment transaction to respond
Referenced SOP Sequence	(0008,1199)	A list of SOP instances that are successfully committed for long-term archiving in PathSpeed™ PACS
> Referenced SOP Class UID	(0008,1150)	SOP Class UID of the instance
> Referenced SOP Instance UID	(0008,1155)	SOP Instance UID of the instance
Failed SOP Sequence	(0008,1150)	A list of SOP instances that are NOT committed for long-term archiving in PathSpeed™ PACS
> Referenced SOP Class UID	(0008,1150)	SOP Class UID of the instance
> Referenced SOP Instance UID	(0008,1155)	SOP Instance UID of the instance
> Failure Reason	(0008,1197)	Reason for that the SOP Instance is not committed for long-term archiving.

TABLE 6-5: DATA ELEMENTS INCLUDED IN FAILURE STORAGE COMMITMENT RESPONSE

The Storage Commitment AE will return the following Failure Reason Code:

Failure Code	Failure Reason	Description
0110H	Processing Failure	Requested SOP Instances are failed for archiving or the PACS installation site is designated not to archive data permanently
0112H	No such object instance	Requested SOP Instances cannot be found in the PathSpeed™ database (still not yet received when the job timer expired).
0213H	Resource Limitation	Requested SOP Instances cannot be archived because of the lack of resource (archiving media, etc.).

TABLE 6-6: FAILURE CODES SUPPORTED BY THE STORAGE COMMITMENT AE

7. PATHSPEED PACS DICOM CONFORMANCE STATEMENT FOR PRINT SERVICE

7.1 INTRODUCTION

PathSpeed™ PACS implements DICOM Print Server (denoted DPS for short in this section) for the PACS users to print the images to a connected DICOM Printer SCP application.

7.2 IMPLEMENTATION MODEL

The DPS creates one single DICOM Application Entity to support the print service.

Multiple DPS instances can run in one PathSpeed™ PACS installation.

7.2.1 Application Data Flow Diagrams

The DPS AE implements the SCU role of the DICOM Basic Grayscale Print Management Meta SOP Class.

With this SCU role, the DPS AE is able to retrieve the printer information, to accept printer status event report and to print images.

The real-world activity triggers the DPS AE to start an association for image print is an image print request issued by the PathSpeed™ Workstation user. However, the print job is performed in an asynchronous way, from the point of view of the Workstation user.

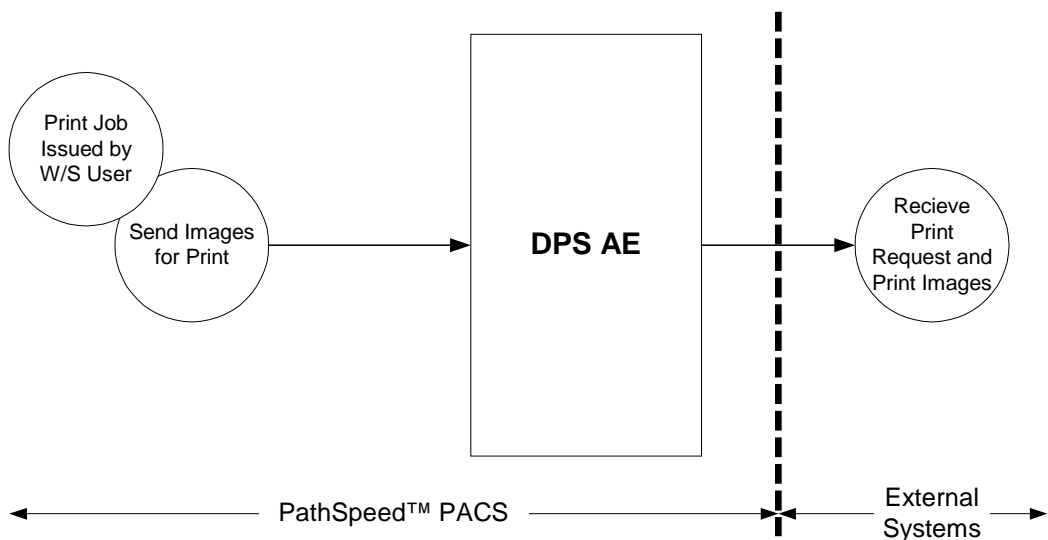


FIGURE 7-1: DATA FLOW DIAGRAM OF STORAGE AE

When starting a print job, the DPS AE attempts to send all images specified in the job to the DICOM Print SCP application for printing. The job will be removed, which indicates a successful completion of the job, only after all images are sent.

Note: With a print job performed, the DPS AE successfully sent all images as well as print formatting information specified in the job to the DICOM Print SCP application for printing. However, the DPS AE cannot guarantee that these images are printed. The user should check the DICOM Conformance Statement of the Print SCP application for the specified actions after a successful completion of DICOM association.

7.2.2 Functional Definitions of AE's

The DPS AE supports the following application-level functions:

- Format a film sheet by filling the images into the film sheet according to the print format requested in the print job.
- Burn all (text and graphic) overlays into the image pixel matrix.
- Perform all densitometric transforms to the pixel data matrix as specified in the print job.
- Perform all spatial transforms to the pixel data matrix as specified in the print job.
- Send the image pixel matrix to the DICOM Print SCP application for print.

7.3 STANDARD SPECIFICATION

The DPS AE provides the Standard Conformance to the DICOM Basic Grayscale Print Management Meta SOP Class, which includes the following SOP Classes:

SOP Class Name	SOP Class 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	1.2.840.10008.5.1.1.16

TABLE 7-1: SCU CONFORMANCE LIST OF SOP CLASSES FOR SEND AE

7.3.1 Association Establishment Policies

The DPS AE initiates a network association to a DICOM Print SCP application for performing a print job, which may include one or several images.

7.3.1.1 General

The DICOM Application Context Name (ACN), which is always proposed by the DPS AE, is

DICOM Application Context Name	1.2.840.10008.3.1.1.1
--------------------------------	-----------------------

The Maximum Length of PDU negotiation is included in an association establishment request. The Maximum Length of PDU proposed for all associations initiated by the DPS AE is configurable (see Section 2.6.7) up to

Maximum Length of PDU	28672 Bytes
-----------------------	-------------

The DPS AE does not propose SOP class Extended Negotiation in any DICOM association it initiates.

The DPS AE does not propose (SCU/SCP) Role Selection Negotiation in any DICOM association it initiates. The default role always applies (The DPS AE plays the SCU role because it initiates an association).

The user information items sent by the DPS AE include

- Maximum Length of PDU
- Implementation Class UID
- Implementation Version Name

7.3.1.2 Number of Associations

The DPS AE is able to initiate multiple associations to different Print SCP Application Entities at a time to perform DIMSE service elements. The maximum number of the simultaneous DICOM associations that can be initiated, is determined by the total number of the remote DICOM Print SCP Application Entities known to the DPS AE.

To each remote DICOM Print SCP Application Entity, the DPS will not initiate another association before the currently operating association is completed.

7.3.1.3 Asynchronous Nature

The DPS AE does not support asynchronous operations. All operations will be performed synchronously.

7.3.1.4 Implementation Identifying Information

The DPS AE provides the implementation class UID, which is:

Implementation Class UID	1.2.840.113619.6.94
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The DPS AE provides the implementation version name, which is:

Implementation Version Name	PathSpeed_8.1
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7.3.1.5 Timers

7.3.1.5.1 Association Timers

The DPS AE supports an association timer, which starts when the association request is sent, and stops when the association is established.

7.3.1.5.2 Operation Inactivity Timer

The DPS AE supports an operation inactivity timer, which re-starts every time a DIMSE service request has been issued.

7.3.2 Real-World Activity: Print Job

The DPS AE keeps pulling the print job queue of the PathSpeed™ PACS system. If one print job is retrieved, it initiates an association to the DICOM Print SCP application specified in the job if

1. There is no association currently running with the requested DICOM Print SCP application.

If the conditions are not met, the print job is waiting for execution until these conditions become fulfilled.

Note: If several printers are served with one DICOM Print Server, which is able to support only one DICOM Application Entity, the DPS AE can operate only one association with the DICOM Print Server simultaneously.

7.3.2.1 Associated Read-World Activity

A PathSpeed™ Workstation user selects one or several or all images from an exam, and issue a print command. The user also specifies the film format as well as the printer, which should perform the print job.

7.3.2.2 Proposed Presentation Contexts

The DPS AE will propose the following presentation context to request a print service to a remote AE.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
SOP Class	UID	Name List	UID List		
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.1.1.9	Explicit VR Big Endian	1.2.840.10008.1.2.2	SCU	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Implicit VR Little Endian	1.2.840.10008.1.2		

TABLE 7-2: PROPOSED PRESENTATION CONTEXT FOR PRINT IMAGES

The columns Transfer Syntaxes in Table 7-2 lists all transfer syntaxes that the DPS AE can propose for the abstract syntax Basic Grayscale Print Management Meta SOP Class. The DPS AE can be configured to propose the presentation context with one or several or all of these transfer syntaxes.

If multiple transfer syntaxes are chosen to be proposed in the presentation context, they are included in the order displayed in Table 7-2.

7.3.2.2.1 SOP Specific Conformance for Print SOP Class

After a successful association negotiation, the DPS AE issues an N-GET-RQ message in order to retrieve the contents of the well-known Printer SOP Instance (SOP Instance UID is 1.2.840.10008.1.1.17).

The attributes list that the DPS AE requests is specified in the following table:

Data Element	Tag	Description
Printer Status	(2100,0010)	Printer device status
Printer Status Info	(2100,0020)	Additional information about printer device
Printer Name	(2100,0030)	Printer name
Manufacturer	(0008,0070)	Manufacturer of the printer
Manufacturer Model Name	(0008,1090)	Manufacturer's model name of the printer
Device Serial Number	(0018,1000)	Manufacturer's serial number of the printer
Software Version	(0018,1020)	Manufacturer's designation of software version of the printer
Date of Last Calibration	(0018,1200)	Date when the printer was last calibrated.
Time of Last Calibration	(0018,1201)	Date when the printer was last calibrated.

TABLE 7-3: ATTRIBUTE LIST REQUESTED BY DPS AE IN N-GET OPERATION

If the N-GET-RQ fails, the DPS AE will release the association and terminate the print job.

The DPS AE accepts N-EVENT-REPORT-RQ from the well-known Printer SOP instance at any time of the life-cycle of the print association.

The DPS will release the association if the Printer Status Info attribute contains one of the following values in either N-GET-RSP or N-EVENT-REPORT-RQ messages received from the called AE:

- "RECEIVER FULL"
- "NO RECEIVE MGZ"
- "PRINTER INIT"
- "SUPPLY EMPTY"
- "NO SUPPLY MGZ"
- "FILM JAM"

In these conditions, the DPS AE assumes that the called AE is not in a normal operating state to continue any print job sent to it. It is also assumed that a manual intervention is required, to correct this condition.

The DPS AE accepts an N-EVENT-REPORT-RSP including any standard event attributes and acknowledges the receipt of the message immediately by sending an N-EVENT-REPORT-RSP message to the well-known Printer SOP instance.

7.3.2.2.2 SOP Specific Conformance for Basic Film Session SOP Class

After a successful check of the Printer attributes (see Section 7.3.2.2.1), the DPS AE creates a Basic Film Session by invoking N-CREATE-RQ message. The following data attributes are provided in the N-CREATE-RQ message:

Data Element	Tag	Value Sent by DPS AE
Number of Copies	(2000,0010)	Number of copies requested. The DPS AE sends value one (1) or two (2).
Print Priority	(2000,0020)	The default value sent by the DPS AE is MEDIUM. Three values can be sent: LOW MEDIUM HIGH These are configured by the DPS user.
Medium Type	(2000,0030)	The default value sent by the DPS AE is CURRENT. Four values can be sent CURRENT PAPER CLEAR_FILM BLUE_FILM These are configured by the DPS user.
Film Destination	(2000,0040)	The default value sent by the DPS AE is CURRENT. Three values can be sent CURRENT MAGAZINE PROCESSOR These are configured by the DPS user.
Film Session Label	(2000,0050)	DICOM_RPINT
Memory Allocation	(2000,0060)	0

TABLE 7-4: ATTRIBUTE LIST OF N-CREATION-RQ FOR CREATION OF BASIC FILM SESSION

The DPS AE waits for receiving an N-CREATE-RSP message from the called AE as response to the Basic Film Session creation request. According to the received N-CREATE-RSP message, the DPS AE behaves as following:

1. If the creation of the Basic Film Session fails, the DPS AE releases the association and terminates the print job.
2. If the creation of the Basic Film Session succeeds, the DPS AE continues to create all film box instances for the print job. After completion of the print job, the DPS AE deletes the Basic Film Session instance by invoking an N-DELETE-RQ message.
3. Except the N-DELETE-RQ message after completion of the entire print job, the DPS AE does not send any message to the created Basic Film Session instance. In particular, the DPS AE never executes the print job at the Basic Film Session level by invoking an N-ACTION-RQ message to the Basic Film Session instance.

7.3.2.2.3 SOP Specific Conformance for Basic Film Box SOP Class

After successful creation of a Basic Film Session instance, the DPS AE creates one Basic Film Box to the Basic Film Session instance. The following attributes will be provided in the N-CREATE-RQ message:

Data Element	Tag	Value Sent by DPS AE
Image Display Format	(2010,0010)	STANDARD\C,R 1 ≤ C ≤ 4 1 ≤ R ≤ 6
Referenced Film Session Sequence	(2010,0500)	
> Referenced SOP Class UID	(0008,1150)	1.2.840.10008.5.1.1.1
> Referenced SOP Instance UID	(0008,1155)	UID returned by the called AE
Film Orientation	(2010,0040)	PORTRAIT
Film Size ID	(2010,0050)	One of the following values: 8IN×10IN 10IN×12IN 10IN×14IN 11IN×14IN 14IN×14IN 14IN×17IN 24CM×24CM 24CM×30CM These are configured by the DPS user.
Magnification Type	(2010,0060)	The default value sent by the DPS AE is CUBIC. Four values can be sent CUBIC REPLICATE BILINEAR NONE These are configured by the DPS user.
Maximum Density	(2010,0130)	The default value sent by the DPS AE is 264. Other values can be if configured by the DPS user. The maximum value can be sent is 400.
Configuration Information	(2010,0150)	A user-defined value can be sent. This value is configured according to the Conformance Statement of the called AE.
Border Density	(2010,0100)	The default value sent by the DPS AE is BLACK. Two values can be sent BLACK WHITE These are configured by the DPS user.
Empty Image Density	(2010,0110)	The default value sent by the DPS AE is BLACK. Two values can be sent BLACK WHITE These are configured by the DPS user.
Minimum Density	(2010,0120)	0
Trim	(2010,0140)	The default value sent by the DPS AE is YES. Two values can be sent YES NO These are configured by the DPS user.

TABLE 7-5: ATTRIBUTE LIST OF N-CREATION-RQ FOR CREATION OF BASIC FILM BOX

In the N-CREATION-RSP message sent to the DPS AE from the called AE, the DPS AE expects to receive a set of created Basic Grayscale Image Box instances. The number of the Basic Grayscale Image Box instances should match to the Image Display Format attribute sent to the called AE.

According to the received N-CREATE-RSP message, the DPS AE behaves as following:

1. If the creation of the Basic Film Box fails, the DPS AE releases the association and terminates the print job.
2. If the creation of the Basic Film Box succeeds, the DPS AE fills the created Image Boxes in the film box by sending the pixel data and other descriptive information (see Section 7.3.2.2.4). After successfully completion of setting all image boxes, the DPS AE invokes an N-ACTION-RQ message to the Basic Film Box to print the film sheet. Finally, the DPS AE deletes the Basic Film Box instance by sending an N-DELETE-RQ message to the called AE.
3. If not all images have printed, the DPS AE will create another Basic Film Box instance and repeat the operations in the last step to print the rest images.

7.3.2.2.4 SOP Specific Conformance for Basic Grayscale Image Box SOP Class

For each Basic Grayscale Image Box created in the Basic Film Box (see Section 7.3.2.2.3), the DPS AE issues a single N-SET-RQ message if an image should be printed in that Basic Grayscale Image Box. No N-SET-RQ message is sent, if a Basic Grayscale Image Box should be blank (no image is printed at this location on the film sheet).

The following data attributes are provided in the N-SET-RQ message:

Data Element	Tag	Value Sent by DPS AE
Image Position	(2020,0010)	An ordinal number of the image in the specified display format.
Basic Grayscale Image Sequence	(0028,0002)	
> Sample per Pixel	(0028,0002)	1
> Photometric Interpretation	(0028,0004)	MONOCHROME2
> Rows	(0028,0010)	Number of rows of the pixel matrix
> Columns	(0028,0011)	Number of columns of the pixel matrix
> Pixel Aspect Ratio	(0028,0034)	This data element is sent if its value is not one (1).
> Bits Allocated	(0028,0100)	16 or 8
> Bits Stored	(0028,0101)	12 or 8
> High Bit	(0028,0102)	11 or 7
> Pixel Representation	(0028,0103)	0
> Pixel Data	(7FE0,0010)	Pixel data stream
Requested Image Size	(2020,0030)	Requested image width in mm. The DPS AE sends this data element only if the user requested a true-size image print.

TABLE 7-6: ATTRIBUTE LIST OF N-SET-RQ FOR FILLING IN IMAGE BOX

7.4 COMMUNICATION PROFILE

7.4.1 Supported Communication Stacks

DICOM Upper Layer (DICOM PS 3.8-1999) is supported by using TCP/IP.

7.4.2 TCP/IP Stack

TCP/IP Network Communication is supported as specified in DICOM PS 3.8-1999.

7.4.3 OSI Stack

Not supported

7.4.4 Physical Media Support

Various network links are supported, including but not limited to 10-BaseT Ethernet, 100-BaseT Ethernet, and ATM OC-3.

The physical media supported depends on network cabling and interfaces equipment available at the PathSpeed™ PACS installation site and interface equipment commercially available.

Equipment list and configuration information for the physical media supported is available upon request.

7.5 EXTENSIONS / SPECIALIZATION / PRIVATIZATION

None.

7.6 CONFIGURATION

The exact method for configuring each configurable item is specified in other PathSpeed™ PACS documentation. The following sections only describe some items that are configurable.

7.6.1 AE Title

The DPS AE Title can be configured by the user. If multiple DPS systems are used in the same PathSpeed™ PACS installation, they can be configured with different AE Titles.

7.6.2 DPS Time-out

Association time-out

Association operation inactivity time-out

7.7 SUPPORT FOR EXTENDED CHARACTER SETS

The DICOM Server supports following character sets:

- ISO-IR-6 (ISO 646)

8. APPENDIX A: IMAGE THUMBNAILS ADDED TO DICOM IMAGES

8.1 IMAGE THUMBNAIL

PathSpeed™ PACS will create a thumbnail for each DICOM Image SOP Instance of the following Photometric Interpretation values:

- MONOCHROME1
- MONOCRHOEM2
- RGB

The thumbnail is derived from the original pixel data by downscaling the image size to 128×128 pixels or less, and added to the original SOP Instance with a private sequence data element in the DICOM Image SOP Instance.

One thumbnail is created per DICOM image. For a multi-frame image, only one thumbnail is created from the center frame. The number of the frame, which is used for the thumbnail creation is included in the Image SOP Instance (see Section 8.3).

In PathSpeed™ PACS, the thumbnails are used by the PathSpeed™ Web display application for image navigation when browsing through a set of images. With the information published in this Appendix, a DICOM application receiving the images from PathSpeed™ PACS can also explore the thumbnail data encoded in the Image SOP Instances.

8.2 IMAGE THUMBNAIL COMPRESSION

The thumbnail is compressed with 8 bits or 12 bits JPEG lossy compression format, depending on the stored pixel depth of the original images.

For all Image SOP Instances with bits stored equal to or less than 8, the thumbnail image is stored one byte per pixel and compressed by JPEG 8-bits lossy compression.

For all Image SOP Instances with bits stored equal to or less 12, the thumbnail image is stored two bytes per pixel and compressed by JPEG 12-bits lossy compression.

For all Image SOP Instances with bits stored greater than 12, the pixel data of the thumbnail image is first shifted to fit into the 12 bits scope and then stored two bytes per pixel. The thumbnail is compressed by JPEG 12-bits lossy compression. The bits shifted is saved in the GE Private Image Thumbnail Sequence, as specified in the next section.

All thumbnails are represented in the unsigned format (either byte or two-bytes (12 bits) integer). If an Image SOP Instance contains a signed pixel data element, the thumbnail pixel data will be offset to the unsigned scope. The offset added is saved in the GE Private Image Thumbnail Sequence, as specified in the next section.

8.3 IMAGE THUMBNAIL ENCODING

PathSpeed™ PACS adds a private sequence data element (GE Private Image Thumbnail Sequence) to an Image SOP Instance for the thumbnail encoding. There is no any change to the existing data attributes of the SOP Instance.

The GE Private Image Thumbnail Sequence is specified in the following table.

Data Element	Tag	VR	VM	Description
Private Creator ID	(0009,00xx)	LO	1	“GEIIS”, Reserve xx00-xxFF of group 0009 in the SOP Instance.
GE Private Image Thumbnail Sequence	(0009,xx10)	SQ	1	Always only one item present
> Sample per Pixel	(0028,0002)	US	1	Copy from the original SOP Instance
> Photometric Interpretation	(0028,0004)	CS	1	Thumbnail Photometric Interpretation. Enumerated Values: MONOCHROME1, MONOCHROME2, RGB
> Planar Configuration	(0028,0006)	US	1	Thumbnail Planar Configuration. Always 0, if present.
> Number of Frames	(0028,0008)	IS	1	Copy from the original SOP Instance. The thumbnail itself is always single frame.
> Rows	(0028,0010)	US	1	Thumbnail Rows of Image Matrix, ≤ 128.
> Columns	(0028,0011)	US	1	Thumbnail Columns of Image Matrix, ≤ 128.
> Bits Allocated	(0028,0100)	US	1	Copy from the original SOP Instance
> Bits Stored	(0028,0101)	US	1	Copy from the original SOP Instance. If this value is 8 or less, the thumbnail JPEG stream is 8 bits compressed, otherwise, it is 12 bits compressed.
> High Bit	(0028,0102)	US	1	Copy from the original SOP Instance
> Pixel Representation	(0028,0103)	US	1	Copy from the original SOP Instance
> Largest Image Pixel Value	(0028,0107)	US/SS	1	Copy from the original SOP Instance
> Pixel Padding Value	(0028,0120)	US/SS	1	Copy from the original SOP Instance
> Window Center	(0028,1050)	DS	1-n	Copy from the original SOP Instance

> Window Level	(0028,1051)	DS	1-n	Copy from the original SOP Instance
> Rescale Intercept	(0028,1052)	DS	1	Copy from the original SOP Instance
> Rescale Slope	(0028,1053)	DS	1	Copy from the original SOP Instance
> Private Creator ID	(0029,0010)	LO	1	“GEIIS”, Reserve 1000-10FF of group 0029 in this item.
> Shift Count	(0029,1010)	UL	1	Number of bits pixel values were shifted down to get them into the 12 bits range before JPEG compression.
> Offset	(0029,1012)	UL	1	Value added to pixel values to convert them from signed to unsigned values before JPEG compression.
> Actual Frame Number	(0029,1014)	UL	1	Actual frame number of image the thumbnail was generated from. For multi-frame images, this should represent the center frame. Only one thumbnail is created for the entire multi-frame image.
> Private Creator ID	(7FD1,0010)	LO	1	“GEIIS”, Reserve 1000-10FF of group 7FD1 in this item.
> GE IIS Compression Type	(7FD1,1010)	UL	1	PathSpeed™ PACS internally used data compression code. Always 26 for thumbnail
> Pixel Data	(7FE0,0010)	OB	1	8 bits or 12 bits JPEG lossy compressed thumbnail image pixel data stream.

TABLE 8-1: SPECIFICATION OF GE PRIVATE IMAGE THUMBNAIL SEQUENCE

The GE Private Image Thumbnail Sequence includes a number of standard data elements directly copied from the original Image SOP Instance, to which the sequence is added. These data elements are marked as *Copy from the original SOP Instance* in Table 8-1. These data elements provide the original pixel data context from that the thumbnail has been derived. Note that they do not contain the values specific to the thumbnail.

The GE Private Image Thumbnail Sequence uses a number of standard data elements to describe the properties of the thumbnail pixel data. Note that these data elements in this sequence really contain the values specific to the thumbnail, but not to the original image pixel data.

9. APPENDIX B: PRIVATE DATA ELEMENTS OF ORIGINAL UID VALUES

When PathSpeed™ PACS change the values of Study Instance UID, Series Instance UID and / or SOP Instance UID, the original UID values are saved as the private data element in the same data set, as shown in the following table.

Data Element	Tag	VR	VM	Description
Private Creator ID	(0907,00xx)	LO	1	“GEIIS”, Reserve xx00-xxFF of group 0009 in the SOP Instance.
Original Study Instance UID	(0907,xx10)	UI	1	The value of the original Study Instance UID, which has been changed into the current value in (0020,000D).
Original Series Instance UID	(0907,xx20)	UI	1	The value of the original Series Instance UID, which has been changed into the current value in (0020,000E).
Original SOP Instance UID	(0907,xx30)	UI	1	The value of the original SOP Instance UID, which has been changed into the current value in (0008,0018).

TABLE 9-1: PRIVATE DATA ELEMENTS FOR ORIGINAL UID VALUES

PathSpeed™ PACS changes the UID values for resolving any conflict of the UID values in the received data set to the UID values maintained in the PathSpeed™ database.

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