RADIOLOGY INFORMATION SYSTEMS
PowerPACS® Archive Server

DICOM 3.0 CONFORMANCE STATEMENT

REVISION HISTORY

Rev.	Date	Reason for Change
01	Novmber 12, 2001	First preliminary version. All pages at revision 01.
02	January 21, 2003	Revised to reflect the new functionality implemented in the Archive Server
03	November 19, 2004	Extended with new funcationality.

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1. Introduction

1.1 Purpose

The DICOM Conformance Statement for the RADinfo Systems' PowerPACS Archive Server specifies the DICOM 3.0 service classes, information objects and communication protocols that PowerPACS Archive Server supports.

1.2 Audience

This manual is intended for system administrators who wish to compare PowerPACS Archive Server with similar products in precise terms defined by NEMA standards, or implement DICOM communication interfaces with PowerPACS Archive Server. We assume that you are familiar with the DICOM protocol.

1.3 Structure

This manual is written and formatted in accordance with the NEMA Standards DICOM Conformance Statement Template.

1.4 Supporting Documents

The following publications contain more related information

Publications	Number
Digital Imaging and Communications in Medicine (DICOM), Part 2: Conformance	NEMA Standards Publication PS3.2
PowerPACS Archive Server User's Guide	

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1.5 Glossary

The following acronyms are used in this manual.

ACR-NEMA	American College of Radiology and National Electrical Manufacturer's Association
AE	Application Entity
ANSI	American National Standards Institute
API	Application programming interface
CT	Computed tomography
DICOM	Digital Imaging and Communications in Medicine
DIMSE	DICOM Message Service Element
RSVS	RADinfo Scan View System
LAN	Local area network
MRI	Magnetic resonance imaging
NM	Nuclear medicine imaging
SC	Secondary captured image
SCP	Service Class Provider

SCU	Service Class User
SOP	Service-Object Pair
TCP/IP	Transport control protocol/internet protocol
UID	Unique Identifier
US	Ultrasonic imaging
WAN	Wide area network

2. Implementation Model

Radiology Information Systems' (RADinfo Systems') PowerPACS Archive Server is an application that interfaces its on-line and near-line archive data storage to DICOM network environment. It collects DICOM image objects from the DICOM network system, stores these images in its image archive storage, and provides a bunch DICOM archive storage maintenance tools for the administrative user to housekeep the image data in the archive storage.

PowerPACS Archive Server provides the following DICOM capacities:

- DICOM 3.0 compliant C-STORE service class provider for receiving images.
- DICOM 3.0 compliant C-ECHO service class provider for DICOM network connectivity verifications.
- DICOM 3.0 compliant Query/Retrieve service class provider for DICOM image data query/retrieve operations.
- DICOM 3.0 compliant Storage Commitment service class provider.
- DICOM 3.0 compliant C-STORE service class user for background image data store operations in a few different circumstances.
- DICOM 3.0 compliant C-ECHO service class user for DICOM communication connectivity verifications.
- DICOM 3.0 compliant Query/Retrieve service class user for seamlessly chained operations to query and retrieve data from a third DICOM Image Server.
- DICOM 3.0 compliant Storage Commitment service class user for chained operations.

This document describes PowerPACS conformance with DICOM 3.0 standard. Refer to the *PowerPACS User's Guide* for detailed documentation of system operation.

2.1 Application Data Flow Diagram

PowerPACS Archive Server provides echo, Query/Retrieve and storage services for DICOM 3.0 standard images using ECHO, C-FIND, C-GET, C-MOVE and C-STORE DIMSE-C Services. PowerPACS provides Storage Commitment SCP and SCU using DIMSE-N Services.

Figure 1 is the data flow diagram for the PowerPACS Archive Server application.

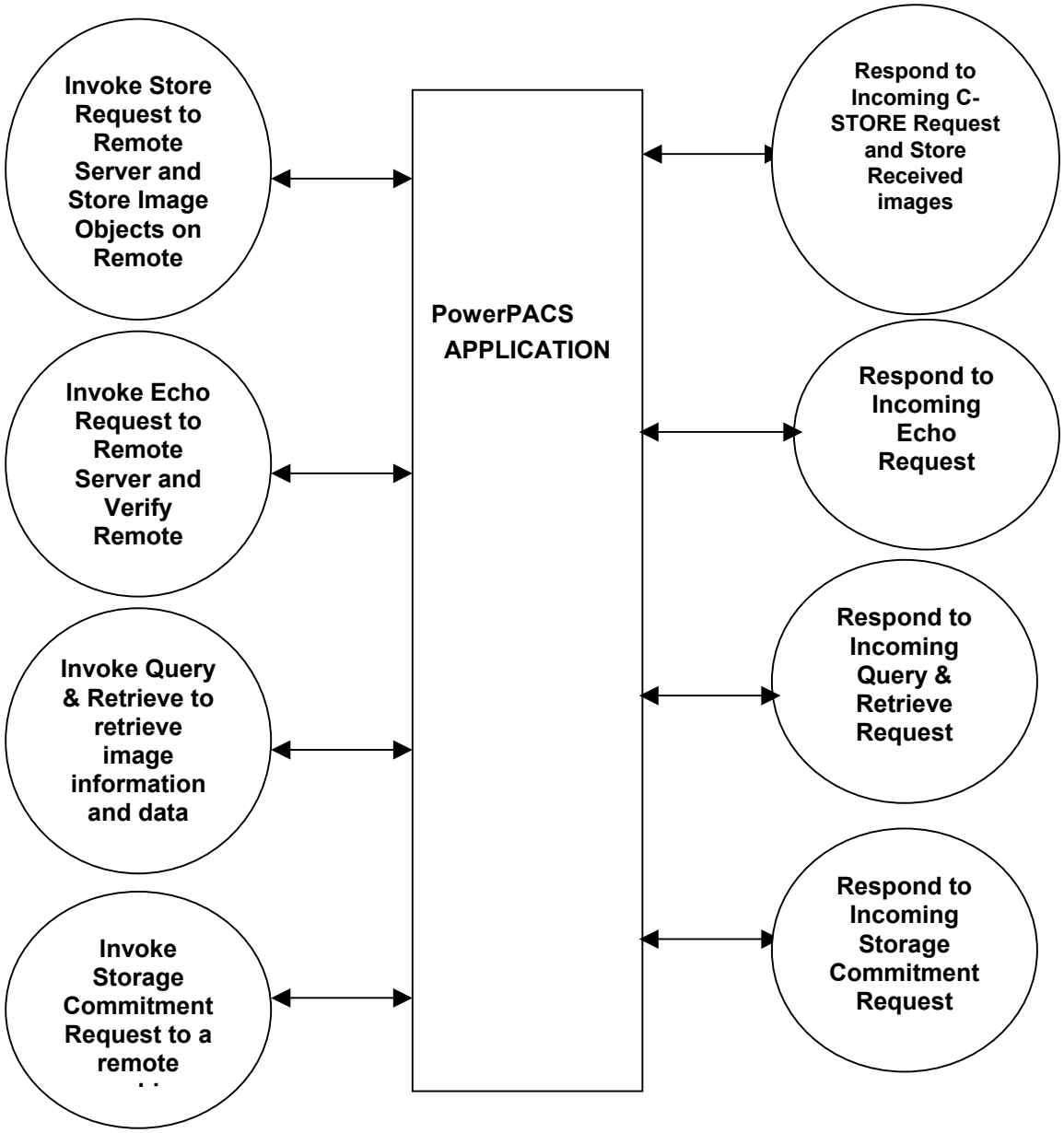

Figure 1. Application Data Flow Diagram

When a C-STORE request is received and it has passed the access control, PowerPACS Archive Server will create a dedicated thread to deal with the request. It receives the image data and stores the image data in its image archive database.

When a C-ECHO request is received, PowerPACS Archive Server will reply with a C-ECHO response to indicate its existence.

When a Query/Retrieve request is received and it has passed the access control, PowerPACS Archive Server will create a dedicated thread to deal with the request. It parses the Identifier data and dynamically construct SQL query to retrieve data from the database, or passes the request to a third Image Archive Server. When it receives data from the database or a remote Server, PowerPACS Archive Server sends the data back to the requester with a response data package. Each data object will be wrapped with a response package. It repeats the responses until all of the retrieved data objects are sent.

When an operation raises a demand to send image to a remote machine, PowerPACS Archive Server will initiate and emit a C-STORE request accordingly. The image data is transmitted to the requested remote along with the request. This operation is performed in background.

When an operation raises a demand to query image information from a third Image Server, PowerPACS Archive Server will trigger one or more Patient Level, Study Level, Series Level and/or Image Level C-FIND requests. This operation is performed in background.

When an operation needs to retrieve image data from a remote node, PowerPACS Archive Server will automatically retrieve this image data from the remote with either C-GET or C-MOVE services. This operation is performed in background.

2.2 Functional Definition of the PowerPACS Archive Server Application Entity

When PowerPACS Archive Server has received an association request, it will examine the following information in the association request.

- Calling AE Title
- Called AE Title
- Abstract Syntax/Transfer Syntax list in the Presentation Context Item
- User Information Item

PowerPACS Archive Server has an Access Control List (ACL) database that contains the access control matrix for each DICOM end user. PowerPACS Archive Server matches the data carried by the association request with the data in the ACL database. When PowerPACS Archive Server determines that at least one or more Abstract Syntax/Transfer Syntax items are allowed for the user, it will construct the association acknowledge accordingly and send the ASSOCIATION-AC package back to the requester. Otherwise, it will issue an ASSOCIATION-RJ package.

Within a single association, PowerPACS Archive Server may deal with one or more DIMSE Service requests until an association release request is received.
When PowerPACS Archive Server receives a C-STORE request, it will create a dedicated thread to perform the C-STORE SCP role, receive DICOM image data,

and save the data to its archive database. After the data is saved, it will issue a C-STORE response back to the requester.

When PowerPACS Archive Server receives a C-ECHO request, it will act as a C-ECHO SCP, and respond to the requester with a C-ECHO response.

When PowerPACS Archive Server receives a C-FIND request, it will create a dedicated thread to handle the request. It uses the Identifier data in the C-FIND request to query the database, or use the Identifier data to issue another C-FIND request to a third Image Server. When it receives the data records from the database or the third Image Server, PowerPACS will send the data back to the requester, with one data record in each response data package. It repeats these response packages with a PENDING status until all of them are sent. The last response will be issued with a SUCCESS status.

When PowerPACS Archive Server receives a C-GET or C-MOVE request, it will create a dedicated thread to handle the request. It uses the Identifier data in the request to query the database, or construct another C-GET or C-MOVE request to query for image objects from a third Image Server. When it receives the data records from the database or the third Image Server, PowerPACS Archive Server will send these image objects back to the requester or a third specified destination with C-STORE services. After each image object is sent, PowerPACS Archive Server will issue one C-GET or C-MOVE response package to the requester. (The response package may or may not be attached with image information record data, depending upon the way the server is configured.) When all images are sent, PowerPACS Archive Server will issue an additional response package with SUCCESS status.

When PowerPACS Archive Server receives a Storage Commitment request, it will perform necessary operations to secure the storage of the SOP Instances specified by the request. It then sends a Storage Commitment response back to the requester. The response package may either be sent through the same association or in a separated association according to its configurations.

The PowerPACS Archive Server issues a DICOM association request for storage service when an internal operation requests to send an image or a series of images to a remote mode. When the association is established between PowerPACS Archive Server and a storage service provider, PowerPACS Archive Server starts sending the image data to the storage service provider.

When an internal operation demands to query some image information from a remote node, PowerPACS Archive Server will issue a DICOM association request for query/retrieve operations. When the association is established, PowerPACS Archive Server will send one or a set of C-FIND requests to the remote node.

When an operation requires getting image data from a remote node, PowerPACS Archive Server will issue one ore more C-GET/C-MOVE requests to the remote to retrieve desired images.

2.3 Sequencing of Real-World Activities

Not applicable.

3. Application Entity Specification

3.1 PowerPACS Archive Server AE Specification

PowerPACS Archive Server provides standard conformance to the DICOM 3.0 Services listed in Table 1.

Table 1 Conformance to SOP Classes as an SCP and/or SCU

SOP Class Name	SOP Class UID	SCP/SCU Roles
Verification	1.2.840.10008.1.1	SCU/SCP
CR Image Storage	1.2.840.10008.5.1.4.1.1.1	SCU/SCP
Digital X-Ray Image Storage	1.2.840.10008.5.1.4.1.1.1.1	SCU/SCP
Digital X-Ray Image Storage – For Processing	1.2.840.10008.5.1.4.1.1.1.1.1	SCU/SCP
Digital X-Ray Mammography Storage	1.2.840.10008.5.1.4.1.1.1.2	SCU/SCP
Digital X-Ray Mammography Storage – For Processing	1.2.840.10008.5.1.4.1.1.1.2.1	SCU/SCP
Digital X-Ray Intra-Oral Image Storage	1.2.840.10008.5.1.4.1.1.1.3	SCU/SCP
Digital X-Ray Intra-Oral Image Storage – For Processing	1.2.840.10008.5.1.4.1.1.1.3.1	SCU/SCP
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	SCU/SCP
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	SCU/SCP
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	SCU/SCP
Nuclear Medicine Image Storage (RET)	1.2.840.10008.5.1.4.1.1.5	SCU/SCP
Ultrasound Image Storage (RET)	1.2.840.10008.5.1.4.1.1.6	SCU/SCP
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	SCU/SCP
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	SCU/SCP
Standalone Overlay Storage	1.2.840.10008.5.1.4.1.1.8	SCU/SCP
Grayscale Softcopy Presentation State Storage	1.2.840.10008.5.1.4.1.1.11.1	SCU/SCP
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	SCU/SCP
X-Ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2	SCU/SCP
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	SCU/SCP
Raw Data Storage	1.2.840.10008.5.1.4.1.1.66	SCU/SCP

VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	SCU/SCP
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2	SCU/SCP
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3	SCU/SCP
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4	SCU/SCP
Basic Text Structured Report	1.2.840.10008.5.1.4.1.1.88.11	SCU/SCP
Enhanced Structured Report	1.2.840.10008.5.1.4.1.1.88.22	SCU/SCP
Comprehensive Structured Report	1.2.840.10008.5.1.4.1.1.88.33	SCU/SCP
Mammography CAD Structured Report	1.2.840.10008.5.1.4.1.1.88.50	SCU/SCP
Key Object Selection Document	1.2.840.10008.5.1.4.1.1.88.59	SCU/SCP
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	SCU/SCP
Patient Root Query/Retrieve – FIND	1.2.840.10008.5.1.4.1.2.1.1	SCU/SCP
Patient Root Query/Retrieve – MOVE	1.2.840.10008.5.1.4.1.2.1.2	SCU/SCP
Patient Root Query/Retrieve – GET	1.2.840.10008.5.1.4.1.2.1.3	SCU/SCP
Study Root Query/Retrieve – FIND	1.2.840.10008.5.1.4.1.2.2.1	SCU/SCP
Study Root Query/Retrieve – MOVE	1.2.840.10008.5.1.4.1.2.2.2	SCU/SCP
Study Root Query/Retrieve – GET	1.2.840.10008.5.1.4.1.2.2.3	SCU/SCP
Patient/Study Only Query/Retrieve – FIND	1.2.840.10008.5.1.4.1.2.3.1	SCU/SCP
Patient/Study Only Query/Retrieve – MOVE	1.2.840.10008.5.1.4.1.2.3.2	SCU/SCP
Patient/Study Only Query/Retrieve – GET	1.2.840.10008.5.1.4.1.2.3.3	SCU/SCP
Storage Commitment Push Model SOP Class	1.2.840.10008.1.20.1	SCU/SCP

3.1.1 Association Establishment Policies

3.1.1.1 General

The DICOM application context is 1.2.840.3.1.1.1. The maximum PDU size is 8192 bytes.

3.1.1.2 Asynchronous Nature

The PowerPACS Archive Server does not support asynchronous operations and does not perform asynchronous window negotiation.

3.1.1.3 Implementation Identifying Information

PowerPACS Archive Server provides an implementation class UID, which is 1234567890.1998.310. PowerPACS Archive Server provides an implementation version name of RIS1998310.

3.1.2 Association Initiation Policy

PowerPACS Archive Server attempts to initiate one association with a remote node in response to each DICOM communication demand raised from internal operations. Any of the conditions listed below will trigger PowerPACS Archive Server to initiate one association.

- When an internal operation demands to retrieve image information from a remote node.
- When an internal operation attempts to retrieve images from a remote node.
- When an internal operation requests to send a series of images to a remote node.
- When an internal operation requests for a Storage Commitment service from a remote node.
- When a Storage Commitment response needs to be carried out in a separated association.

3.1.3 Associated Real-World Activities

3.1.3.1 Receive Images from Remote Node

The associated real-world activity is that when the PowerPACS Archive Server receives a C-STORE request in an association, it will examine the context ID of the request package. Further, it will receive the image data. After the image data is received, it will perform a data integrity test over the image data. Finally, it will perform overall structural integrity test over the image data with existing database data. When the image successfully passes all of these tests, it will be stored in PowerPACS Archive Server's image Storage. If the image failed at any stage of the tests, it would be stored in a temporary storage and be listed in an error list. The administrative user can access the error list and correct the data with PowerPACS Archive Server database maintenance utilities.

3.1.3.2 Send Images to Remote Node

The associated real-world activity is that when a C-STORE request is demanded by an internal operation, the PowerPACS Archive Server application will try to initiate an association. Once the association is successfully established, application selected images are transferred from the PowerPACS server to a third destination DICOM node that is assigned to store the images.

If a multi-frame image is originally compressed, the PowerPACS Archive Server will try its best to avoid decompression and compression operations on the image in the send process.

3.1.3.3 Respond to a Query/Retrieve Request

The associated real-world activity is as follows. When the PowerPACS Archive Server receives a C-FIND, C-GET or C-MOVE request, it will use the Identifier data to query the database, or reconstruct a C-FIND, C-GET or C-MOVE request to invoke a request to a third Image Server. If it is a C-FIND service, when the PowerPACS receives image information data from the database or the remote node, it will wrap the information into C-FIND response packages. One C-FIND response is for each image record. It repeats C-FIND responses until all records are sent. If it is a C-GET or C-MOVE service, when it receives images from the database or the remote node, it will change its role to C-STORE SCU and issue C-STORE request to the destination. In C-GET, the destination is the requester. In the C-MOVE service, the destination can be a third party. Furthermore, in C-MOVE, a new association will be initiated for C-STORE operations. After each image object is transmitted, PowerPACS issues a C-GET or C-MOVE response back to the requester. The response may or may not be attached with an Identifier data.

3.1.3.4 Request Image Information/Data from Remote Node

The associated real-world activity is that when a PowerPACS Archive Server internal operation demands the need for a query/retrieve service from a remote node, PowerPACS Archive Server will attempt to initiate an association with that remote node for this query/retrieve operation. Once the association is established, PowerPACS Archive Server issues a C-FIND, C-GET or C-MOVE Request to the remote node. Sometimes, the C-MOVE request may be assigned with an image destination with the AE Title of this PowerPACS Archive Server itself. During a C-GET request, PowerPACS will reverse its role to C-STORE SCP to receive image objects in the same association. When PowerPACS Archive Server receives image objects from the remote node, it will test image data integrity as the way in C-STORE SCP operations. Qualified images from the test will be saved to its Archive Storage. Images that are failed in the test will be saved in a temporary storage, and are listed in an error list.

3.1.3.5 Respond to a Storage Commitment Request

The associated real-world activity is that when PowerPACS Archive Server receives a Storage Commitment request from a remote node, it will perform necessary operations to secure the image objects specified by the request. After the images are considered secure, PowerPACS Archive Server will issue a Storage Commitment response to the requester. The response may or may not be in the same association as the request is in. If the response is in a different association, PowerPACS Archive Server will attempt to establish an association with the requester for the Storage Commitment response (an N-EVENT-REPORT service).

3.1.3.6 Request a Storage Commitment Service from Remote Node

The associated real-world activity is as follows. When an internal operation requests for a Storage Commitment service from a remote node, the PowerPACS Archive Server will attempt to initiate an association with that remote node. When the association is established, PowerPACS Archive Server sends the Storage Commitment request using an N-ACTION service. If it is configured to perform N-EVENT-REPORT in the same association, PowerPACS Archive Server will wait for the N-EVENT-REPORT. If it is configured to receive N-EVENT-REPORT in a separated association, PowerPACS will release the association after it receives N-ACTION response, and PowerPACS Archive Server's N-EVENT-REPORT SCP will wait for the Storage Commitment response.

3.1.3.7 Proposed Presentation Contexts

The PowerPACS Archive Server supports the following transfer syntaxes for the storage SOP classes.

Table 2 Transfer Syntaxes supported for image storage SOP classes

UID	Description
1.2.840.10008.1.2	Implicit VR Little Endian
1.2.840.10008.1.2.1	Explicit VR Little Endian
1.2.840.10008.1.2.4.50	JPEG Baseline: Lossy JPEG 8 Bit Image Compression
1.2.840.10008.1.2.4.57	JPEG Lossless, Non-Hierarchical
1.2.840.10008.1.2.4.70	JPEG Lossless, Non-Hierarchical, First-Order Prediction.
1.2.840.10008.1.2.5	RLE Lossless

The PowerPACS Archive Server supports the Implicit VR Little Endian transfer syntax (1.2.840.10008.1.2) and Explicit VR Little Endian transfer syntax (1.2.840.10008.1.2.1) for all other DICOM DIMSE services.

3.1.4 SOP Specific Conformance

3.1.4.1 SOP Specific Conformance for Query/Retrieve Service Class

PowerPACS Archive Server supports the most commonly used query/retrieve attributes in its Query/Retrieve Service Class. These attributes are listed in Table 3.

Table 3 Supported Query/Retrieve Identifier Attributes

Tag	Attribute Name	Level	Supported Search Types
0010, 0010	Patient Name	Patient	Wild card, universal, exact match
0010, 0020	Patient ID	Patient	Wild card, universal, exact

			match, list
0010, 0030	Patient Date of Birth	Patient	Universal, exact match, range
0010, 0040	Patient Sex	Patient	Universal, exact match
0020, 1200	Total Studies in the Patient	Patient	Universal
0020, 1202	Total Series in the Patient	Patient	Universal
0020, 1204	Total Images in the Patient	Patient	Universal
0008, 0020	Study Date	Study	Universal, exact match, range
0008, 0030	Study Time	Study	Universal, exact match, range
0008, 0050	Accession Number	Study	Wild card, universal, exact match
0008, 1030	Study Description	Study	Wild card, universal, exact match
0020, 000D	Study Instance UID	Study	Universal, exact match, list
0020, 0010	Study ID	Study	Wild card, universal, exact match
0020, 1206	Total Series in the Study	Study	Universal
0020, 1208	Total Images in the Study	Study	Universal
0008, 0060	Modality	Series	Universal, exact match, list
0020, 000E	Series Instance UID	Series	Universal, exact match, list
0020, 0011	Series Number	Series	Wild card, universal, exact match
0020, 1209	Total Images in the Series	Series	Universal
0008, 0018	SOP Instance UID	Image	Universal, exact match, list
0020, 0013	Image Number	Image	Wild card, universal, exact match

In a Study Root Study Level Query/Retrieve, all the attributes listed in the Patient Level and Study Level in Table 2 are supported.

4. Communication Profiles

4.1 TCP/IP

PowerPACS Archive Server uses the TCP/IP stream socket from Microsoft WinSocket.

4.2 Physical Media Support

PowerPACS Archive Server provides no restriction on the physical network. PowerPACS Archive Server can operate using TCP/IP over Ethernet (Thick Wire, Thin Wire, 10 BaseT, etc.), FDDI (twisted pair into a concentrator, fiber backbone), and commercial telephone network.

5. Support of Extended Character Sets

PowerPACS Archive Server presently provides no support for extended character sets in its current version.