RadZen DCMQ

DICOM Queuing System

Version 2

DICOM Conformance Statement

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1 Revision History

Revision	Author	Date	Description
1	Andrew Tie	12/04/2007	Created document for RadZen DCMQ version 2.0.7

2 Introduction

RadZen DCMQ is a DICOM 3.0 compliant network appliance that queues DICOM C-STORE requests from one or more source DICOM AEs for transmission to a target DICOM AE.

The RadZen DCMQ network appliance includes hardware, operating system and the RadZen DCMQ software. The RadZen DCMQ network appliance is also available as a VMWare Virtual Machine which can be using VMWare Server. VMWare Server is a free product from VMWare Inc. (http://www.vmware.com) that runs on Windows, Linux and MacOS platforms.

This implementation of RadZen DCMQ is designed to provide the following features:

- RadZen DCMQ runs as a standalone network appliance on its own hardware or as a virtual machine. This makes it much easier to deploy and provides better reliability.
- The application provides temporary storage for images. It accepts images from remote DICOM AE's and stores them for later transmission. These images are removed from the system once they have been successfully transmitted.
- RadZen DCMQ uses DICOM as the interface to external conforming clients. The DICOM server accepts DICOM association requests for the purpose of storing images. RadZen DCMQ will initiate DICOM association requests for the purpose of sending images to an external destination server. RadZen DCMQ does not respond to any other type of network communication.
- RadZen DCMQ uses a web server as the interface for viewing and managing the queued images, and for configuring queue parameters through a web browser.
- Transmission of images may be encrypted using Transport Layer Security for secure transmission over an insecure channel such as the Internet. For this feature to work, the destination network server must support DICOM over TLS and must be configured with the correct digital certificates.

RadZen DCMQ utilises the dcm4che toolkit version 2.0.x by Gunter Zeilinger (http://www.dcm4che.org) which implements the DICOM 2006 standard.

3 Abbreviations

ASCII	American Standard Code for Information Interchange
AE	Application Entity
AE-Title	name of an AE
ANSI	American National Standards Institute
CR	Computed Radiography
CT	Computed Tomography
ISDN	Integrated Service Digital Network
DICOM	Digital Imaging and Communications in Medicine
DCMQ	DICOM Queue
ECR	European Congress of Radiology
GPRS	General Packet Radio Service
GSPS	Grayscale Softcopy Presentation State
HIMSS	Healthcare Information and Management Systems Society
IE	Information Entity
IHE	Integrating the Healthcare Enterprise
IOD	Information Object Definition
ISO	International Standards Organization
NEMA	National Electrical Manufacturers Association
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
RSNA	Radiological Society of North America
SCP	Service Class Provider
SCU	Service Class User
SOP	Service Object Pair
TCP/IP	Transmission Control Protocol / Internet Protocol
SSL	Secure Sockets Layer
TLS	Transport Layer Security
UID	Unique Identifier
VM	Value Multiplicity
VR	Value Representation

4 Implementation Model

RadZen DCMQ runs as a standalone network appliance which includes the CentOS 4 Linux operating system, the RadZen DCMQ software and either hardware or a VMWare virtual machine.

The RadZen DCMQ software is able to service a configurable number of concurrent DICOM C-STORE or C-ECHO requests. DICOM images are stored on the system and queued for transmission. At regular intervals it opens an association to the configured target DICOM AE and sends the queued images to the target AE one at a time. RadZen DCMQ Software will store the received DICOM data in the event of loss of connectivity and will send the data once the target DICOM AE becomes available.

Inbound and outbound AEs may be configured via the administration web interface as with SSL/TLS and most of the network transmission parameters. Some network parameters such as IP address, DHCP and network traffic management may be configured by Future Zen on request.

4.1 Application Data Flow Diagram

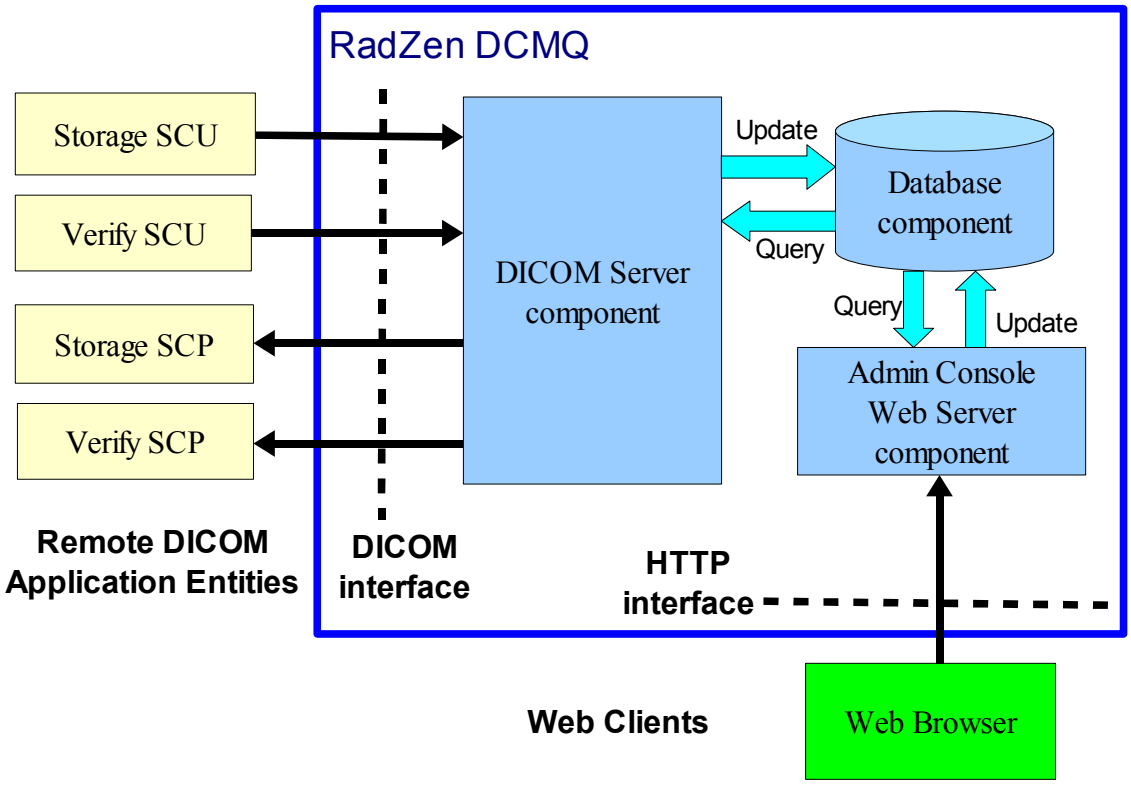

FIGURE 1. RadZen DCMQ Implementation Model

RadZen DCMQ is designed to enable DICOM data transfer over low-bandwidth connections. It may also be used to enable encrypted DICOM data transfer over insecure channels such as the

Internet.

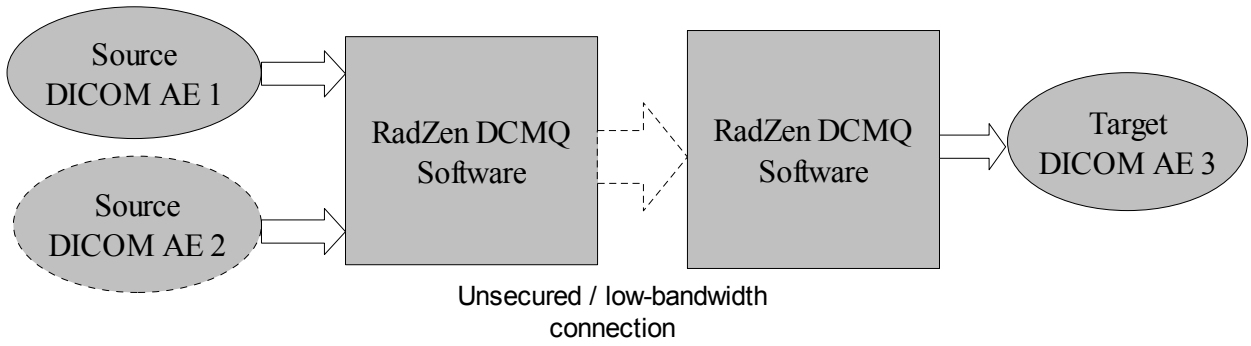

FIGURE 2. Transmission over an unsecured or low-bandwidth connection

4.2 Functional Definitions of Application Entities

RadZen DCMQ waits for another application to connect to the TCP/IP port number specified in its configuration. When a DICOM association request is received, RadZen DCMQ uses its configuration and the following logic to verify the incoming request:

- RadZen DCMQ is strict when verifying the Called Application Entity Title of the incoming association request. It will reject an incoming association request if the Called Application Entity Title does not match the configured Queue Inbound AE Title.
- RadZen DCMQ will accept requests from any AE title.

When transmitting images, RadZen DCMQ can be configured to use a set Queue Outbound Calling AE Title, or to masquerade as the Calling AE Title of the original request.

4.3 Sequencing of Real-World Activities

See the Association Initiation and Acceptance Policy sections below on real-world activities for all SOP classes supported by RadZen DCMQ.

5 AE Specifications

RadZen DCMQ starts automatically when the power button on the appliance is switched on. RadZen DCMQ is able to handle a configurable number of incoming connections. This configuration parameter can be set using the administration web interface.

5.1 AE RadZen DCMQ – Specification

RadZen DCMQ provides Standard Conformance to the following DICOM 3.0 SOP Classes as both SCU and SCP:

SOP Class Name	SOP Class UID
Verification SOP Class	1.2.840.10008.1.1
Basic Study Content Notification SOP Class (Retired)	1.2.840.10008.1.9
Stored Print Storage SOP Class (Retired)	1.2.840.10008.5.1.1.27
Hardcopy Grayscale Image Storage SOP Class (Retired)	1.2.840.10008.5.1.1.29
Hardcopy Color Image Storage SOP Class (Retired)	1.2.840.10008.5.1.1.30
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1
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
Digital Mammography X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.2
Digital Mammography X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.2.1
Digital Intra-oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.3
Digital Intra-oral X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.3.1
Standalone Modality LUT Storage (Retired)	1.2.840.10008.5.1.4.1.1.10
Encapsulated PDF Storage	1.2.840.10008.5.1.4.1.1.104.1
Standalone VOI LUT Storage (Retired)	1.2.840.10008.5.1.4.1.1.11
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1
Color Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.2
Pseudo-Color Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.3
Blending Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.4
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1
Enhanced XA Image Storage	1.2.840.10008.5.1.4.1.1.12.1.1
X-Ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2
Enhanced XRF Image Storage	1.2.840.10008.5.1.4.1.1.12.2.1
X-Ray Angiographic Bi-Plane Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.12.3
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128
Standalone PET Curve Storage (Retired)	1.2.840.10008.5.1.4.1.1.129
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20
Ultrasound Multi-frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.3
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1
MR Spectroscopy Storage	1.2.840.10008.5.1.4.1.1.4.2
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1

RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
RT Beams Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.4
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5
RT Brachy Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.6
RT Treatment Summary Record Storage	1.2.840.10008.5.1.4.1.1.481.7
Nuclear Medicine Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.5
Ultrasound Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.6
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1
Raw Data Storage	1.2.840.10008.5.1.4.1.1.66
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1
Spatial Fiducials Storage	1.2.840.10008.5.1.4.1.1.66.2
Real World Value Mapping Storage	1.2.840.10008.5.1.4.1.1.67
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7
Multi-frame Single Bit Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.1
Multi-frame Grayscale Byte Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.2
Multi-frame Grayscale Word Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.3
Multi-frame True Color Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.4
VL Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.77.1
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1
Video Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1.1
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2
Video Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2.1
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
Video Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4.1
Ophthalmic Photography 8 Bit Image Storage	1.2.840.10008.5.1.4.1.1.77.1.5.1
Ophthalmic Photography 16 Bit Image Storage	1.2.840.10008.5.1.4.1.1.77.1.5.2
Stereometric Relationship Storage	1.2.840.10008.5.1.4.1.1.77.1.5.3
VL Multi-frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.77.2
Standalone Overlay Storage (Retired)	1.2.840.10008.5.1.4.1.1.8
Basic Text SR	1.2.840.10008.5.1.4.1.1.88.11
Enhanced SR	1.2.840.10008.5.1.4.1.1.88.22
Comprehensive SR	1.2.840.10008.5.1.4.1.1.88.33
Procedure Log Storage	1.2.840.10008.5.1.4.1.1.88.40
Mammography CAD SR	1.2.840.10008.5.1.4.1.1.88.50

Key Object Selection Document	1.2.840.10008.5.1.4.1.1.88.59
Chest CAD SR	1.2.840.10008.5.1.4.1.1.88.65
Standalone Curve Storage (Retired)	1.2.840.10008.5.1.4.1.1.9
12-lead ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.1
General ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.2
Ambulatory ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.3
Hemodynamic Waveform Storage	1.2.840.10008.5.1.4.1.1.9.2.1
Cardiac Electrophysiology Waveform Storage	1.2.840.10008.5.1.4.1.1.9.3.1
Basic Voice Audio Waveform Storage	1.2.840.10008.5.1.4.1.1.9.4.1
Hanging Protocol Storage	1.2.840.10008.5.1.4.38.1
Siemens CSA Non-Image Storage	1.3.12.2.1107.5.9.1

TABLE 1. SOP Classes Supported by RadZen DCMQ as a SCU and SCP

5.2 Association Establishment Policies

5.2.1 General

The maximum PDU size which can be transmitted by RadZen DCMQ is configurable (4-64 Kbytes). The maximum PDU size which can be received by RadZen DCMQ is also configurable (4-64 Kbytes).

5.2.2 Number of Associations

The number of simultaneous associations which can be accepted by RadZen DCMQ are limited only by the kernel parameters of underlying TCP/IP implementation of CentOS 4, the Sun Java Virtual Machine and resource utilization. RadZen DCMQ creates a new thread to service each association request that it receives. Therefore, RadZen DCMQ can have multiple simultaneous connections, and there is no inherent limitation on the total number of simultaneous associations which RadZen DCMQ can maintain.

5.2.3 Asynchronous Nature

RadZen DCMQ does not support asynchronous operations and will not perform asynchronous window negotiation.

5.2.4 Implementation Identifying Information

RadZen DCMQ provides the following implementation class UID:

1.2.40.0.13.1.1

RadZen DCMQ provides the following implementation version name (this reflects the use of the dcm4che toolkit):

dcm4che-2.0

5.3 Association Initiation Policy

RadZen DCMQ will attempt to initiate associations to verify DICOM connection status (C-ECHO) to the destination remote Application Entity (AE).

RadZen DCMQ will attempt to initiate associations to forward (C-STORE) images to a remote destination application entity (AE) if the verification of the connection has been successful.

5.3.1 Outbound Connection Verification

5.3.1.1 Associated Real-World Activity

RadZen DCMQ will automatically attempt to verify the destination remote AE prior to attempting to forward images. The queue outbound status will be set to 'OK' if the C-ECHO request is successfully acknowledged by the remote AE, otherwise the status will be set to 'ERROR'. The queue status is displayed on the administration web interface.

5.3.1.2 Proposed Presentation Contexts

The table below shows the presentation contexts that are proposed by RadZen DCMQ for verification operations.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Verification	1.2.840.10008.1.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

TABLE 2. Presentation Contexts proposed when sending a C-ECHO request

5.3.1.3 SOP Specific Conformance Statement

RadZen DCMQ provides standard conformance for DICOM SOP Verification class.

5.3.2 Forwarding Images

5.3.2.1 Associated Read-World Activity

RadZen DCMQ checks the queue regularly and attempts to send a C-STORE request to a target AE

if it there are images queued for transmission. The result of C-STORE request to the target AE is returned to the source AE.

The target connection data (hostname, port number, preferred transfer syntax) is determined from the queue outbound configuration parameters.

The transfer syntax of image data is changed if the target AE accepts another transfer syntax than the original one.

If the target AE does not respond or if the transmission is interrupted, the status of the queue entry for the image is changed to 'Error'. RadZen DCMQ will attempt to send the image 3 times before moving on to the next entry. The number of retries may be configured via the administration web interface.

5.3.2.2 Proposed Presentation Contexts

RadZen DCMQ proposes the Storage Service class as SCU as received with the currently handled request from the source AE.

Presentation Context Table			
Abstract Syntax			
Name	**UID**	**Role**	**Extended Negotiation**
As sent by source	As sent by source	SCU	None

TABLE 3. Presentation Contexts proposed when sending a C-STORE request

The following transfer syntaxes are proposed:

Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1
Explicit VR Big Endian	1.2.840.10008.1.2.2

5.4 Association Acceptance Policy

5.4.1 Inbound Connection Verification

RadZen DCMQ accepts associations from applications that wish to perform a verification (C-ECHO) operation on the RadZen DCMQ.

5.4.1.1 Associated Real World Activity

The real-world activity associated with the C-ECHO request is that an external application wishes to verify network or server operation without initiating any actual work.

5.4.1.2 Presentation Context Table

The table below shows the presentation contexts that may be accepted by RadZen DCMQ for verification operations.

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Verification	1.2.840.10008.1.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

TABLE 4. Presentation Contexts accepted for C-ECHO requests

5.4.1.3 SOP Specific Conformance for SOP Class

RadZen DCMQ provides standard conformance for DICOM SOP Verification class.

5.4.1.4 Presentation Context Acceptance Criterion

RadZen DCMQ will accept any number of verification SOP classes, provided that the request has specified a Calling AE Title that matches that of the queue inbound interface. RadZen DCMQ defines no limit on the number of presentation contexts accepted. In the event that RadZen DCMQ runs out of resources when trying to accept multiple presentation contexts, RadZen DCMQ will reject the association request.

RadZen DCMQ does not check for duplicate presentation contexts and will accept duplicate presentation contexts.

5.4.1.5 Transfer Syntax Selection Policies

RadZen DCMQ will accept any of the following transfer syntaxes for verification requests:

Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1
Explicit VR Big Endian	1.2.840.10008.1.2.2

5.4.2 Sending Images to the Queue

RadZen DCMQ accepts associations from applications that wish to send images to the queue using the C-STORE command.

5.4.2.1 Associated Real-World Activity

The associated Real-World activity associated with the C-STORE operation is the storage of the

images on the disk of the RadZen DCMQ system. Images are stored by writing the data set of the C-STORE command directly to disk.

After an image is stored to disk, RadZen DCMQ updates the database and adds a new entry to the queue. This database also stores the configuration data that can be modified via the administration web interface.

RadZen DCMQ abort the association if it is unable to store the image on disk, if the image does not conform to the IOD of the SOP class under which it was transmitted, or if the RadZen DCMQ is not able to successfully update its database.

5.4.2.2 Presentation Context Table

The following Presentation Contexts will be accepted by RadZen DCMQ when receiving images:

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
Name	**UID**	**Name List**	**UID List**		
Basic Study Content Notification SOP Class (Retired)	1.2.840.10008.1.9	See Transfer Syntax Selection Policies Below		SCP	None
Stored Print Storage SOP Class (Retired)	1.2.840.10008.5.1.1.27	See Transfer Syntax Selection Policies Below		SCP	None
Hardcopy Grayscale Image Storage SOP Class (Retired)	1.2.840.10008.5.1.1.29	See Transfer Syntax Selection Policies Below		SCP	None
Hardcopy Color Image Storage SOP Class (Retired)	1.2.840.10008.5.1.1.30	See Transfer Syntax Selection Policies Below		SCP	None
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1	See Transfer Syntax Selection Policies Below		SCP	None
Digital X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.1	See Transfer Syntax Selection Policies Below		SCP	None
Digital X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.1.1	See Transfer Syntax Selection Policies Below		SCP	None
Digital Mammography X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.2	See Transfer Syntax Selection Policies Below		SCP	None
Digital Mammography X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.2.1	See Transfer Syntax Selection Policies Below		SCP	None
Digital Intra-oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.3	See Transfer Syntax Selection Policies Below		SCP	None
Digital Intra-oral X-Ray Image Storage - For	1.2.840.10008.5.1.4.1.1.1.3.1	See Transfer Syntax Selection Policies Below		SCP	None

Processing				
Standalone Modality LUT Storage (Retired)	1.2.840.10008.5.1.4.1.1.10	See Transfer Syntax Selection Policies Below	SCP	None
Encapsulated PDF Storage	1.2.840.10008.5.1.4.1.1.104.1	See Transfer Syntax Selection Policies Below	SCP	None
Standalone VOI LUT Storage (Retired)	1.2.840.10008.5.1.4.1.1.11	See Transfer Syntax Selection Policies Below	SCP	None
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1	See Transfer Syntax Selection Policies Below	SCP	None
Color Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.2	See Transfer Syntax Selection Policies Below	SCP	None
Pseudo-Color Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.3	See Transfer Syntax Selection Policies Below	SCP	None
Blending Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.4	See Transfer Syntax Selection Policies Below	SCP	None
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	See Transfer Syntax Selection Policies Below	SCP	None
Enhanced XA Image Storage	1.2.840.10008.5.1.4.1.1.12.1.1	See Transfer Syntax Selection Policies Below	SCP	None
X-Ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2	See Transfer Syntax Selection Policies Below	SCP	None
Enhanced XRF Image Storage	1.2.840.10008.5.1.4.1.1.12.2.1	See Transfer Syntax Selection Policies Below	SCP	None
X-Ray Angiographic Bi-Plane Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.12.3	See Transfer Syntax Selection Policies Below	SCP	None
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	See Transfer Syntax Selection Policies Below	SCP	None
Standalone PET Curve Storage (Retired)	1.2.840.10008.5.1.4.1.1.129	See Transfer Syntax Selection Policies Below	SCP	None
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	See Transfer Syntax Selection Policies Below	SCP	None
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1	See Transfer Syntax Selection Policies Below	SCP	None
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	See Transfer Syntax Selection Policies Below	SCP	None
Ultrasound Multi-frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.3	See Transfer Syntax Selection Policies Below	SCP	None
Ultrasound Multi-frame Image Storage	1.2.840.10008.5.1.4.1.1.3.1	See Transfer Syntax Selection Policies Below	SCP	None
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	See Transfer Syntax Selection Policies Below	SCP	None

Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1	See Transfer Syntax Selection Policies Below	SCP	None
MR Spectroscopy Storage	1.2.840.10008.5.1.4.1.1.4.2	See Transfer Syntax Selection Policies Below	SCP	None
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	See Transfer Syntax Selection Policies Below	SCP	None
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2	See Transfer Syntax Selection Policies Below	SCP	None
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	See Transfer Syntax Selection Policies Below	SCP	None
RT Beams Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.4	See Transfer Syntax Selection Policies Below	SCP	None
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	See Transfer Syntax Selection Policies Below	SCP	None
RT Brachy Treatment Record Storage	1.2.840.10008.5.1.4.1.1.481.6	See Transfer Syntax Selection Policies Below	SCP	None
RT Treatment Summary Record Storage	1.2.840.10008.5.1.4.1.1.481.7	See Transfer Syntax Selection Policies Below	SCP	None
Nuclear Medicine Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.5	See Transfer Syntax Selection Policies Below	SCP	None
Ultrasound Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.6	See Transfer Syntax Selection Policies Below	SCP	None
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	See Transfer Syntax Selection Policies Below	SCP	None
Raw Data Storage	1.2.840.10008.5.1.4.1.1.66	See Transfer Syntax Selection Policies Below	SCP	None
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1	See Transfer Syntax Selection Policies Below	SCP	None
Spatial Fiducials Storage	1.2.840.10008.5.1.4.1.1.66.2	See Transfer Syntax Selection Policies Below	SCP	None
Real World Value Mapping Storage	1.2.840.10008.5.1.4.1.1.67	See Transfer Syntax Selection Policies Below	SCP	None
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7	See Transfer Syntax Selection Policies Below	SCP	None
Multi-frame Single Bit Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.1	See Transfer Syntax Selection Policies Below	SCP	None
Multi-frame Grayscale Byte Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.2	See Transfer Syntax Selection Policies Below	SCP	None
Multi-frame Grayscale Word Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.3	See Transfer Syntax Selection Policies Below	SCP	None
Multi-frame True Color	1.2.840.10008.5.1.4.1.1.7.4	See Transfer Syntax	SCP	None

Secondary Capture Image Storage		Selection Policies Below		
VL Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.77.1	See Transfer Syntax Selection Policies Below	SCP	None
VL Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1	See Transfer Syntax Selection Policies Below	SCP	None
Video Endoscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.1.1	See Transfer Syntax Selection Policies Below	SCP	None
VL Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2	See Transfer Syntax Selection Policies Below	SCP	None
Video Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.2.1	See Transfer Syntax Selection Policies Below	SCP	None
VL Slide-Coordinates Microscopic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.3	See Transfer Syntax Selection Policies Below	SCP	None
VL Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4	See Transfer Syntax Selection Policies Below	SCP	None
Video Photographic Image Storage	1.2.840.10008.5.1.4.1.1.77.1.4.1	See Transfer Syntax Selection Policies Below	SCP	None
Ophthalmic Photography 8 Bit Image Storage	1.2.840.10008.5.1.4.1.1.77.1.5.1	See Transfer Syntax Selection Policies Below	SCP	None
Ophthalmic Photography 16 Bit Image Storage	1.2.840.10008.5.1.4.1.1.77.1.5.2	See Transfer Syntax Selection Policies Below	SCP	None
Stereometric Relationship Storage	1.2.840.10008.5.1.4.1.1.77.1.5.3	See Transfer Syntax Selection Policies Below	SCP	None
VL Multi-frame Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.77.2	See Transfer Syntax Selection Policies Below	SCP	None
Standalone Overlay Storage (Retired)	1.2.840.10008.5.1.4.1.1.8	See Transfer Syntax Selection Policies Below	SCP	None
Basic Text SR	1.2.840.10008.5.1.4.1.1.88.11	See Transfer Syntax Selection Policies Below	SCP	None
Enhanced SR	1.2.840.10008.5.1.4.1.1.88.22	See Transfer Syntax Selection Policies Below	SCP	None
Comprehensive SR	1.2.840.10008.5.1.4.1.1.88.33	See Transfer Syntax Selection Policies Below	SCP	None
Procedure Log Storage	1.2.840.10008.5.1.4.1.1.88.40	See Transfer Syntax Selection Policies Below	SCP	None
Mammography CAD SR	1.2.840.10008.5.1.4.1.1.88.50	See Transfer Syntax Selection Policies Below	SCP	None
Key Object Selection Document	1.2.840.10008.5.1.4.1.1.88.59	See Transfer Syntax Selection Policies Below	SCP	None
Chest CAD SR	1.2.840.10008.5.1.4.1.1.88.65	See Transfer Syntax Selection Policies Below	SCP	None
Standalone Curve Storage (Retired)	1.2.840.10008.5.1.4.1.1.9	See Transfer Syntax Selection Policies Below	SCP	None

12-lead ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.1	See Transfer Syntax Selection Policies Below	SCP	None
General ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.2	See Transfer Syntax Selection Policies Below	SCP	None
Ambulatory ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.3	See Transfer Syntax Selection Policies Below	SCP	None
Hemodynamic Waveform Storage	1.2.840.10008.5.1.4.1.1.9.2.1	See Transfer Syntax Selection Policies Below	SCP	None
Cardiac Electrophysiology Waveform Storage	1.2.840.10008.5.1.4.1.1.9.3.1	See Transfer Syntax Selection Policies Below	SCP	None
Basic Voice Audio Waveform Storage	1.2.840.10008.5.1.4.1.1.9.4.1	See Transfer Syntax Selection Policies Below	SCP	None
Hanging Protocol Storage	1.2.840.10008.5.1.4.38.1	See Transfer Syntax Selection Policies Below	SCP	None
Siemens CSA Non-Image Storage	1.3.12.2.1107.5.9.1	See Transfer Syntax Selection Policies Below	SCP	None

TABLE 5. Presentation Contexts accepted by RadZen DCMQ for C-STORE requests

5.4.2.3 Presentation Context Acceptance Criterion

RadZen DCMQ will accept any number of storage SOP classes that are listed in the table above, provided that the Called AE Title specified in the request matches that of the Inbound side of the queue.

RadZen DCMQ defines no limit on the number of presentation contexts accepted. In the event that RadZen DCMQ runs out of resources when trying to accept multiple presentation contexts, RadZen DCMQ will abort the association request.

RadZen DCMQ does not check for duplicate presentation contexts and will accept duplicate presentation contexts in the association request.

5.4.2.4 Transfer Syntax Selection Policies

RadZen DCMQ can be configured to supports different transfer syntax sets. This can be configured via the administration web interface. The transfer syntaxes supported for each configuration value is as follows:

Configuration Option Value	Transfer Syntax	UID
Default Only	Implicit VR Little Endian	1.2.840.10008.1.2
Native Only	Implicit VR Little Endian	1.2.840.10008.1.2
	Explicit VR Little Endian	1.2.840.10008.1.2.1
	Explicit VR Big Endian	1.2.840.10008.1.2.2

Native Little-Endian Only	Implicit VR Little Endian	1.2.840.10008.1.2
	Explicit VR Little Endian	1.2.840.10008.1.2.1
Non-retired Little-Endian Only	JPEG-LS Lossless Image Compression	1.2.840.10008.1.2.4.80
	JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70
	JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
	JPEG 2000 Image Compression (Lossless Only)	1.2.840.10008.1.2.4.90
	Deflated Explicit VR Little Endian	1.2.840.10008.1.2.1.99
	RLE Lossless	1.2.840.10008.1.2.5
	Explicit VR Little Endian	1.2.840.10008.1.2.1
	Implicit VR Little Endian	1.2.840.10008.1.2
	JPEG Baseline (Process 1)	1.2.840.10008.1.2.4.50
	JPEG Extended (Process 2 & 4)	1.2.840.10008.1.2.4.51
	JPEG-LS Lossy (Near-Lossless) Image Compression	1.2.840.10008.1.2.4.81
	JPEG 2000 Image Compression	1.2.840.10008.1.2.4.91
	MPEG2 Main Profile @ Main Level	1.2.840.10008.1.2.4.100
Non-retired	JPEG-LS Lossless Image Compression	1.2.840.10008.1.2.4.80
	JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70
	JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
	JPEG 2000 Image Compression (Lossless Only)	1.2.840.10008.1.2.4.90
	Deflated Explicit VR Little Endian	1.2.840.10008.1.2.1.99
	RLE Lossless	1.2.840.10008.1.2.5
	Explicit VR Little Endian	1.2.840.10008.1.2.1
	Explicit VR Big Endian	1.2.840.10008.1.2.2
	Implicit VR Little Endian	1.2.840.10008.1.2
	JPEG Baseline (Process 1)	1.2.840.10008.1.2.4.50
	JPEG Extended (Process 2 & 4)	1.2.840.10008.1.2.4.51
	JPEG-LS Lossy (Near-Lossless) Image Compression	1.2.840.10008.1.2.4.81
	JPEG 2000 Image Compression	1.2.840.10008.1.2.4.91
	MPEG2 Main Profile @ Main Level	1.2.840.10008.1.2.4.100

TABLE 6. Supported Transfer Syntaxes for each Queue Inbound Transfer Syntax configuration value

6 Communication Profiles

6.1 TCP/IP Stack

RadZen DCMQ provides DICOM V3.0 TCP/IP Network Communication Support as defined in Part 8 of the Standard.

6.1.1 TCP/IP API

RadZen DCMQ uses the Sun Java Virtual Machine API which uses the TCP/IP stack on the CentOS 4 Linux platform upon which it executes.

7 Extensions/Specializations/Privatizations

Not applicable

8 Configuration

RadZen DCMQ obtains configuration information from a database table which is stored in a relational database. In this implementation, the relational database is the open source MySQL database.

8.1 AE Title/Presentation Address Mapping

AE title and presentation address mapping can be configured via the administration web interface. RadZen DCMQ will be restarted automatically when changes to the configuration have been saved.

8.2 Security Features

RadZen DCMQ supports SSL/TLS which utilise digital certificates for authentication and encryption purposes for both inbound and outbound transmissions. If SSL/TLS is enabled, any remote entities interacting with RadZen DCMQ must have the correct corresponding digital certificates and SSL/TLS enabled.

8.3 Configurable Parameters

The following parameters may be configured via the administration web interface:

8.3.1 General Settings

- Sleep duration – the time interval between checking for images to transmit

8.3.2 SSL/TLS Settings

These settings are configured independently for Inbound and Outbound sides of the queue:

- Enable TLS/SSL
- Cipher Suite to use for negotiation and subsequent encryption of data
- TLS/SSL protocols to use
- Digital certificate key store path and password
- Digital certificate trust store path and password

8.3.3 Socket-level Settings

These settings are configured independently for Inbound and Outbound sides of the queue:

- Socket close delay
- Socket send buffer
- Socket receive buffer
- Toggle enable TCP delay

8.3.4 Queue Outbound Settings

- Toggle Masquerade AE title – use the AE title of the application that sent the image
- Calling AE title – mutually exclusive to Masquerade AE title
- Number of times to attempt sending an image if transmission fails
- Local hostname – IP address or hostname of the network interface to send on
- Called AE title – AE title of the destination application
- Remote hostname – IP address or hostname of the destination application
- Remote port number
- Toggle Pack one PDV per PDU only
- Send PDU length – default is 16 Kbytes
- Receive PDU length – default is 16 Kbytes
- DICOM transmission priority
- Association reaper period
- Connection timeout
- Association Accept timeout
- Association Release timeout
- Association Response timeout
- Transcoder buffer size

8.3.5 Queue Inbound Settings

- Called AE Title – AE title of the Inbound side of the queue
- Hostname – IP address/hostname of the network interface to listen for incoming requests on
- Service port number

- Accepted Transfer Syntaxes
- File buffer size when writing data to the disk – default is 1 Kbyte
- Maximum asynchronous operations – maximum number of concurrent threads allowed
- Toggle Pack one PDV per PDU only
- Association reaper period
- Connection timeout
- Association Accept timeout
- Association Release timeout
- Association Response timeout
- Association Idle timeout
- Response delay period (debug/test feature used for emulating high latency connections)

8.3.6 Non-User Configurable Settings

The following parameters may be configured by Future Zen on request and are not configurable via the administration web interface as they are parameters of the CentOS 4 operating system:

- Network IP address
- Network mask
- Gateway IP address
- Enable DHCP client
- Outbound bandwidth throttle (default is 512 Kbps)

These parameters will be made configurable in future implementations of RadZen DCMQ.

8.4 Support of Extended Character Sets

RadZen DCMQ currently does not support any extended character sets.