DICOM CONFORMANCE STATEMENT

RadZen DCMQ

DICOM Queue Network Device

Version 3.1

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1 Table of Contents

2 Revision History

Revision	Author	Date	Description
1	Andrew Tie	15/06/2018	Created document for RadZen DCMQ version 3.0.0

3 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 one or more target DICOM AEs.

The RadZen DCMQ network appliance is a Docker virtual machine that includes a Debian-based operating system, Microsoft .NetCore for Linux and the RadZen DCMQ software.

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

- RadZen DCMQ runs as a standalone network appliance in a Docker container on a Docker server (for Windows or for Linux). This makes it much easier to deploy and provides better reliability by encapsulating the software in an insulated operating environment.
- The application provides temporary storage for instances. It accepts instances from remote DICOM AE's and stores them for later transmission. These objects are removed over time 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 instances. RadZen DCMQ will initiate DICOM association requests for the purpose of sending objects to an external destination server. RadZen DCMQ does not respond to any other type of network communication other than the web traffic described below.
- RadZen DCMQ uses a web server as the interface for viewing and managing the queued instances, and for configuring routing and queue parameters through a web browser.
- Instances may be routed to a destination based on the source AE Title or called AE Title of the incoming instance.
- Transmission of instances may be encrypted using Transport Layer Security for secure transmission over an insecure channel such as the Internet. For this feature to work, the connected modalities must support DICOM over TLS and must be configured with the correct digital certificates. Only SSL server authentication is supported.
- Outbound traffic can be throttled to improve reliability and performance of low-bandwidth connections.

RadZen DCMQ utilises the Fellow Oak DICOM toolkit (https://github.com/fo-dicom/fo-dicom) which implements the DICOM 2017c dictionary.

3.1 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 Networking

4.1 Implementation Model

RadZen DCMQ runs as a standalone network appliance within a Docker container which includes the Debian Linux operating system, Microsoft .NETCore for Linux, and the RadZen DCMQ software.

The RadZen DCMQ can service a configurable number of concurrent DICOM C-STORE or C-ECHO requests. Instances are stored on the system and routed and queued for transmission. At regular intervals it opens an association to the configured target DICOM AE and sends the queued objects to the target AE one at a time.

RadZen DCMQ 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.

Multiple queues and therefore multiple target DICOM AE's may be configured. Incoming instances are routed to the outbound queue based a set of configured routing rules.

Inbound AE's, routing rules and outbound AE's may be configured via the administration web interface. Additional parameters such as use of TLS/SSL and performance parameters can also be configured via the administration web interface.

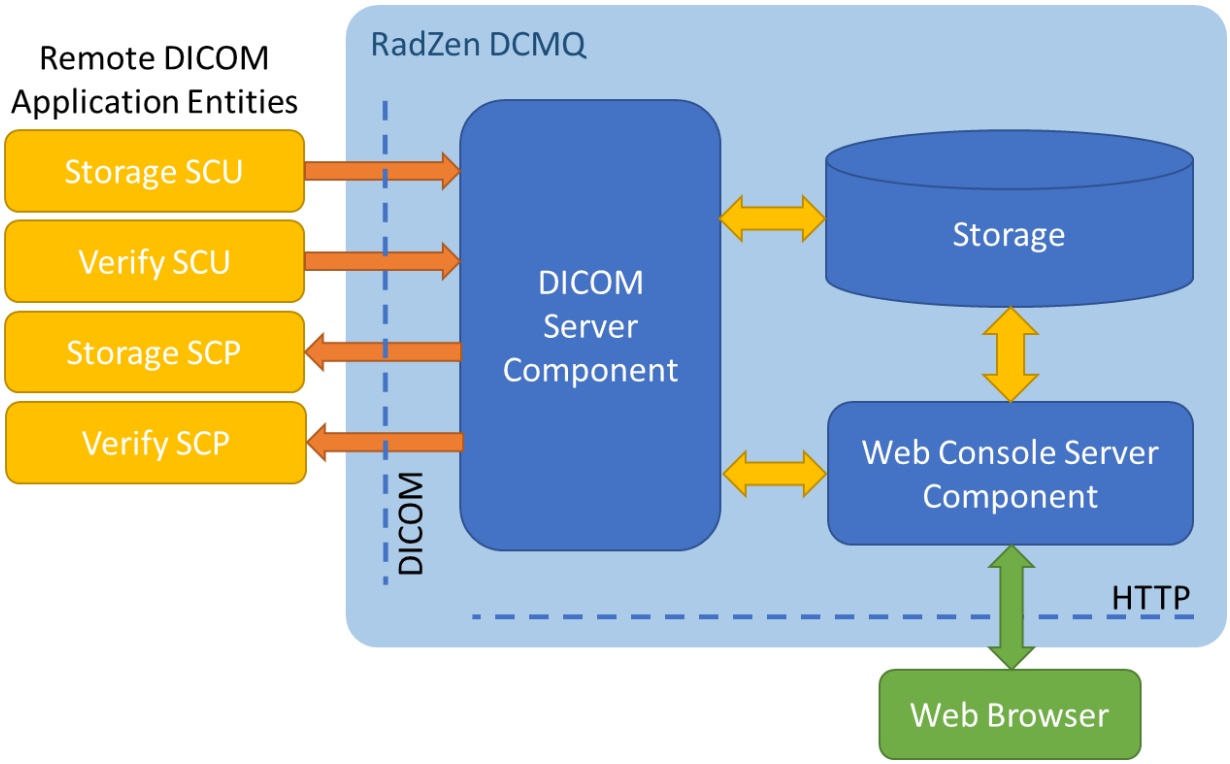

FIGURE 1. RadZen DCMQ Implementation Model

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.

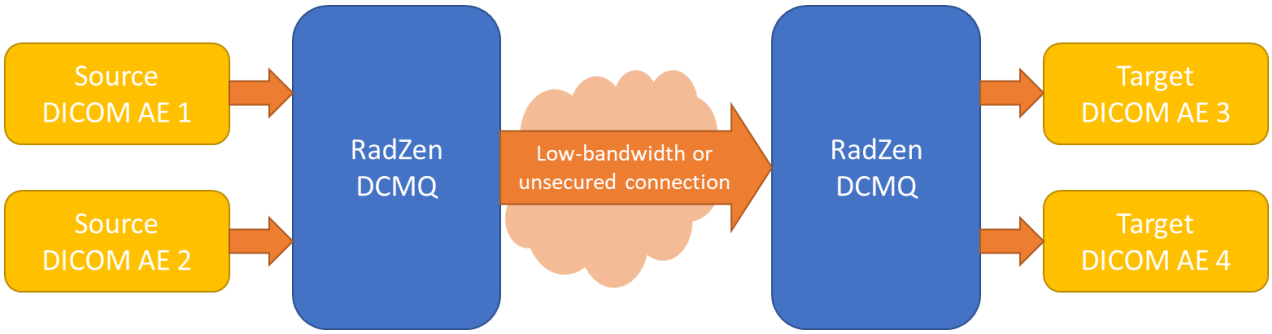

FIGURE 2. Transmission over an unsecured or low-bandwidth connection

5 Application Data Flow Diagram

Local real-world activities shown on the left of Figure 3 below occur as automated activities within RadZen DCMQ. These real-world activities are triggered by a remote real-world activity, such as receiving instances from a remote application, or by an internal process such as routing instances to a queue.

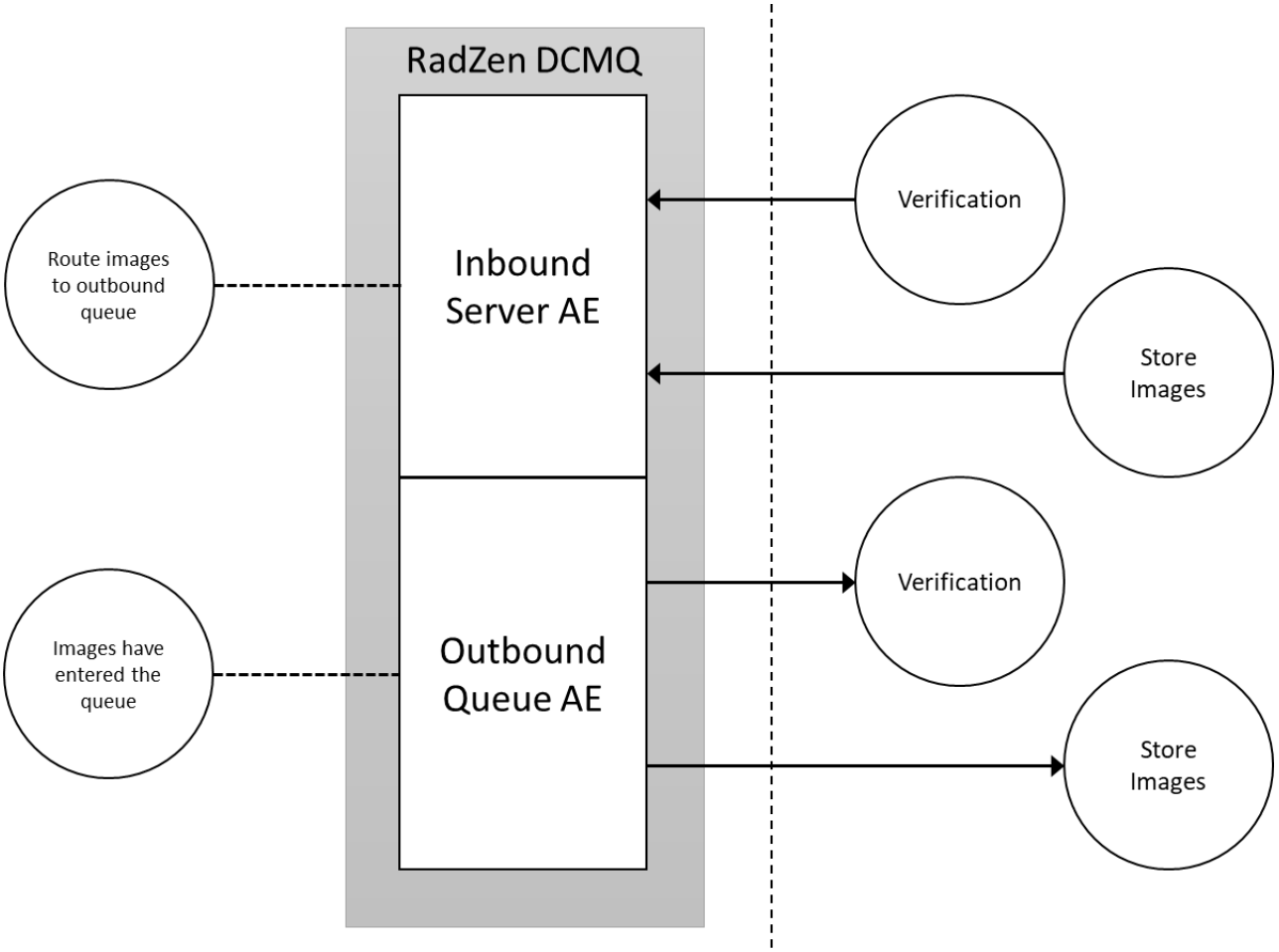

FIGURE 3. RadZen DCMQ Implementation Model Data Flow Diagram

5.1.1 Functional Definitions of Application Entities

5.1.1.1 Inbound Server AE

The Inbound Server AE waits for association requests on the port number specified in its Inbound Server configuration. When a DICOM association request is received, RadZen DCMQ uses its Inbound Server configuration and the following logic to verify the incoming request:

- RadZen DCMQ verifies the Called Application Entity Title of the incoming association request against its configuration. It will reject an incoming association request if the Called Application

Entity Title does not match the configured Inbound AE Title unless the Inbound AE Title is a wildcard (*).

- RadZen DCMQ will accept requests from any AE title.

The following operations may be requested by remote applications:

- **Verification**: If a C-ECHO-RQ message is received, the Inbound Server AE will send back a C-ECHO-RSP message with a status of “success”.

- **Storage**: If a C-STORE-RQ message is received, the Inbound Server AE will receive the instance and try to update the local database. If the instance is stored successfully on storage media and the database updated, a status of “success” will be returned in a C-STORE-RSP message.

5.1.1.2 Outbound Queue AE

Instances received by the Inbound Server AE are routed to an Outbound Queue AE within RadZen DCMQ for transmission. When an Outbound Queue AE has one or more objects, it will initiate the following operations:

- **Verification**: Initiate an association with a Remote AE to verify its status with a C-ECHO-RQ. The Remote AE will report its status in a C-ECHO-RSP.

- **Storage**: Initiate an association to a Remote AE for the purpose of sending instances to the Remote AE. If the Remote AE accepts the presentation context applicable to the object(s) being sent, the Outbound Queue AE will send the object(s) to the receiving Remote AE by invoking the C-STORE-RQ operation for each object on the same association.

When transmitting instances, 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.

5.1.2 Sequencing of Real-World Activities

The following scenarios relate different activities in time:

5.1.2.1 Routing

Receive Instance ➔ Send Instance

When an instance is received, the C-STORE request and the associated instance are matched to routing rules and queued for transmission to one or more remote Application Entities.

5.2 AE Specifications

RadZen DCMQ starts automatically when it’s Docker container is started. RadZen DCMQ can handle a configurable number of incoming connections. This configuration parameter can be set using the Administration Console web interface.

5.2.1 Inbound Server

5.2.1.1 SOP Classes

RadZen DCMQ provides Standard Conformance to the following SOP Classes as a 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

SOP Class Name	SOP Class UID
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

TABLE 1. SOP Classes Supported by the Inbound Server

5.2.1.2 Association Establishment Policies

GENERAL

The maximum PDU size which can be transmitted by the Inbound Server is fixed at 16 Kbytes. The maximum PDU size which can be received by the Inbound Server is up to 16 Kbytes.

NUMBER OF ASSOCIATIONS

The number of simultaneous associations which can be accepted by the Inbound Server is configurable but is unlimited by default in which case the actual number of simultaneous associations are limited only by the kernel parameters of underlying TCP/IP implementation of Debian Linux, the Docker container and resource utilization.

The Inbound Server creates a new thread to service each association request that it receives. Therefore, the Inbound Server can have multiple simultaneous connections, and there is no inherent limitation on the total number of simultaneous associations which it can maintain.

In the case where the number of simultaneous associations is limited by configuration, any incoming associations exceeding this limit will block until the number of simultaneous associations drops below the limit.

ASYNCHRONOUS NATURE

The Inbound Server can have a configurable number of asynchronous operations and will perform asynchronous window negotiation as required.

IMPLEMENTATION IDENTIFYING INFORMATION

The Inbound Server provides the following implementation class UID:

```
1.3.6.1.4.1.30071.8
```

The Inbound Server provides the following implementation version name (this reflects the use of the Fellow Oak DICOM toolkit):

```
fo-dicom 4.0.0
```

5.2.1.3 Association Acceptance Policy

INBOUND CONNECTION VERIFICATION

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

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.

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

SOP SPECIFIC CONFORMANCE FOR SOP CLASS

The Inbound Server provides standard conformance for DICOM SOP Verification class.

PRESENTATION CONTEXT ACCEPTANCE CRITERION

The Inbound Server will accept any number of verification SOP classes, provided that the request has specified a Calling AE Title that matches that of the inbound interface unless it is configured to be promiscuous. The Inbound Server defines no limit on the number of presentation contexts accepted.

If the Inbound Server runs out of resources when trying to accept multiple presentation contexts, the Inbound Server will reject the association request.

The Inbound Server does not check for duplicate presentation contexts and will accept duplicate presentation contexts.

TRANSFER SYNTAX SELECTION POLICIES

The Inbound Server will accept any of the following transfer syntaxes for verification requests:

Transfer Syntax	UID
Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1

SENDING INSTANCES TO DCMQ

The Inbound Server accepts associations from applications that wish to send Instances to DCMQ using the C-STORE command.

ASSOCIATED REAL-WORLD ACTIVITY

The associated Real-World activity associated with the C-STORE operation is the storage of the Instances on the disk of the RadZen DCMQ system. Instances are stored by writing the data set of the C-STORE command directly to disk.

After an Instance is stored to disk, the Inbound Server processes the C-STORE request and Instance against the set of Routing Rules to determine which queues to route the object to. It then updates the database with new entries for each queue that the object is to be routed to.

If a request/Instance does not match any Routing Rules, an entry is written to the database with a status of ‘Orphaned’. Orphaned entries may be manually moved to a queue via the administration console web interface.

The Inbound Server will abort the association if it is unable to store the Instance on disk, if the Instance does not conform to the IOD of the SOP class under which it was transmitted, or if the Inbound Server is not able to successfully update its database.

PRESENTATION CONTEXT TABLE

The following Presentation Contexts will be accepted by the Inbound Server when receiving instances:

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 Processing	1.2.840.10008.5.1.4.1.1.1.3.1	See Transfer Syntax Selection Policies Below		SCP	None
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

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
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

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
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

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Multi-frame True Color Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7.4	See Transfer Syntax Selection Policies Below		SCP	None
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

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
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

TABLE 5. Presentation Contexts accepted by the Inbound Server for C-STORE requests

PRESENTATION CONTEXT ACCEPTANCE CRITERION

The Inbound Server 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 unless it is configured to be promiscuous.

The Inbound Server defines no limit on the number of presentation contexts accepted. If RadZen DCMQ runs out of resources when trying to accept multiple presentation contexts, the Inbound Server will abort the association request.

The Inbound Server does not check for duplicate presentation contexts and will accept duplicate presentation contexts in the association request.

TRANSFER SYNTAX SELECTION POLICIES

The Inbound Server supports the following transfer syntaxes as a SCP:

Transfer Syntax	UID
Implicit VR Little Endian	1.2.840.10008.1.2
Explicit VR Little Endian	1.2.840.10008.1.2.1
Deflated Explicit VR Little Endian	1.2.840.10008.1.2.1.99
RLE Lossless	1.2.840.10008.1.2.5
JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70

Transfer Syntax	UID
JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
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 Lossless Image Compression	1.2.840.10008.1.2.4.80
JPEG-LS Lossy (Near-Lossless) Image Compression	1.2.840.10008.1.2.4.81
JPEG 2000 Image Compression (Lossless Only)	1.2.840.10008.1.2.4.90
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 by the Inbound Server

5.2.2 Outbound Queue

5.2.2.1 SOP Classes

5.2.2.2 Association Establishment Policies

GENERAL

The maximum PDU size which can be transmitted by an Outbound Queue is fixed at 16 Kbytes. The maximum PDU size which can be received by an Outbound Queue is up to 16 Kbytes.

NUMBER OF ASSOCIATIONS

An Outbound Queue is designed to only initiate 1 association at a time. RadZen DCMQ may have more than one Outbound Queue configured and therefore the RadZen DCMQ system as a whole may initiate as many simultaneous associations as there are configured queues.

ASYNCHRONOUS NATURE

An Outbound Queue can have a configurable number of asynchronous operations and will perform asynchronous window negotiation as required.

IMPLEMENTATION IDENTIFYING INFORMATION

An Outbound Queue provides the following implementation class UID:

```
1.3.6.1.4.1.30071.8
```

An Outbound Queue provides the following implementation version name (this reflects the use of the Fellow Oak DICOM toolkit):

```
fo-dicom 4.0.0
```

5.2.2.3 Association Initiation Policy

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

An Outbound Queue will attempt to initiate associations to forward (C-STORE) instances to a remote destination application entity (AE) if the verification of the connection has been successful.

OUTBOUND CONNECTION VERIFICATION

ASSOCIATED REAL-WORLD ACTIVITY

An Outbound Queue will automatically attempt to verify the destination remote AE prior to attempting to forward instances. The Outbound Queue status will be set to 'Running' if the C-ECHO request is successfully acknowledged by the remote AE, otherwise the status will be set to 'Destination Down'. This status is displayed on the administration web interface.

PROPOSED PRESENTATION CONTEXTS

The table below shows the presentation contexts that are proposed by an Outbound Queue 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

SOP SPECIFIC CONFORMANCE STATEMENT

An Outbound Queue provides standard conformance for DICOM SOP Verification class.

FORWARDING INSTANCES

ASSOCIATED READ-WORLD ACTIVITY

An Outbound Queue checks the queue regularly and attempts to send a C-STORE request to a target AE if it there are instances 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, AE title) is determined from the Outbound Queue configuration parameters.

PROPOSED PRESENTATION CONTEXTS

The Outbound Queue proposes the Storage Service class as SCU with the currently handled request using the Presentation Context as received from the source AE.

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

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

The following transfer syntaxes are proposed:

Transfer Syntax	UID
Transfer syntax of the instance as sent by the source	
Implicit VR Little Endian	1.2.840.10008.1.2

SOP SPECIFIC CONFORMANCE

When sending an instance, if the destination SCP negotiates for a different transfer syntax from the proposed one, the Outbound Queue will attempt to transcode the instance into the negotiated transfer syntax on-the-fly.

On-the-fly transcoding of the following transfer syntaxes is not supported:

Transfer Syntax	UID
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 Baseline (Process 1)	1.2.840.10008.1.2.4.50
JPEG Extended (Process 2 & 4)	1.2.840.10008.1.2.4.51
MPEG2 Main Profile @ Main Level	1.2.840.10008.1.2.4.100

With unsupported transcoding operations, the result of the C-STORE operation varies depending on the transcoding operation from the association being aborted, to the pixel data being stripped from the transferred instance.

If the target AE does not respond, the transcoding operation is unsupported or if the transmission is interrupted, the status of the queue entry for the instance is changed to 'Error'.

An Outbound Queue will attempt to send the instance a configured number of times before moving on to the next entry. The number of retries may be configured via the administration web interface.

5.3 Network Interfaces

5.3.1 Physical Network Interface

RadZen DCMQ is indifferent to the physical medium over the underlying operating system and hardware.

5.3.2 Additional Protocols

RadZen DCMQ conforms to the following additional protocols defined in PS3.15.

Profile Name	Actor	Protocols Used	Optional Transactions	Security Support
Network Address Management	DNS Client	DNS	Not applicable	
Time Synchronization	NTP Client	DTP	Find NTP Server	

5.3.2.1 DNS

DNS can be used for address resolution. By default, the RadZen DCMQ Docker container inherits DNS settings from the Docker host. DNS settings can be overridden when launching the Docker container.

See for https://docs.docker.com/config/containers/container-networking/#dns-services further details.

5.3.2.2 NTP

The NTP client implements the optional Find NTP Server transaction. The NTP client will issue an NTP broadcast to identify any local NTP servers. If no local servers can be found via NTP broadcast, the NTP servers identified by to the Docker host via DHCP will be used as time references. Additionally, one or more NTP servers can be configured via the Docker host operating system. If no NTP Servers are identified, then the local clock will be used as a time reference.

5.3.2.3 IPv4 and IPv6 Support

RadZen DCMQ supports IPv4.

5.4 Configuration

RadZen DCMQ obtains configuration information from a database stored on a Docker volume. Only user profiles (secured with a password) with the Administrator role will be able to change the configuration using the web-based Administration Console.

5.4.1 AE Title/Presentation Address Mapping

AE title and presentation address mappings for the Inbound Server and Outbound Queues can be configured via the administration web interface. The appropriate components will be restarted automatically when changes to the configuration have been saved.

5.4.2 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.

5.4.3 Configurable Parameters

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

5.4.3.1 Inbound Server Configuration

GENERAL

- AE Title
- Port to listen for DICOM requests on – use this in conjunction with the Docker Run command to set up the port mappings
- Toggle TLS/SSL
- Certificate name (.PFX only)

- Certificate Password

PERFORMANCE

- Maximum number of clients allowed
- Maximum command buffer size
- Maximum data buffer size
- Maximum number of PDVs per PDU
- Toggle TCP No Delay

5.4.3.2 Queue Definition

LOCAL

- Toggle Masquerade AE title – use the AE title of the application that sent the instance
- AE title – calling AE Title, mutually exclusive to Masquerade AE title
- Address – IP address of the network interface to send on

DESTINATION

- AE title – AE title of the destination application
- Address – IP address or hostname of the destination application
- Port number
- Toggle TLS/SSL
- Ignore TLS/SSL policy errors – when using self-signed certificates

PERFORMANCE

- Minimum send duration – time between sends
- Maximum number of retries
- Maximum transmission rate
- Asynchronous operations invoked
- Asynchronous operations performed
- Send Timeout – time before a send is considered hung

5.4.3.3 Routing Rules

- Match Source AE
- Match Destination AE
- Queue to assign the instance to

6 Media Interchange

RadZen DCMQ does not support Media Interchange.

7 Support of Character Sets

RadZen DCMQ does not offer support for character sets other than the default character repertoire.

8 Security

RadZen DCMQ is assumed to be used within a secured environment which includes at a minimum:

- Firewall or router protections to ensure that only approved external hosts have network access to RadZen DCMQ.
- Firewall or router protections to ensure that RadZen DCMQ only has network access to approved external hosts and services.
- Any communication with external hosts and services outside the locally secured environment use appropriate secure network channels, such as a Virtual Private Network (VPN) or have TLS/SSL encryption enabled.

Other network security procedures such as automated intrusion detection may be appropriate in some environments. Additional security features may be established by the local security policy and are beyond the scope of this conformance statement.

8.1 Security Profiles

RadZen DCMQ does not support Security Profiles.

8.2 Association Level Security

RadZen DCMQ can be configured to check the Called AE Title when determining whether to accept Association Open Requests.

8.3 Application Level Security

Application Level Security is not supported.