CARESTREAM Cardiology PACS

DICOM Conformance Statement

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1 Introduction

This document will specify *CARESTREAM* Cardiology PACS conformance to the DICOM 3.0 standard. Cardiology PACS provides a mechanism for image and non-image data management and archival services. This document will cover the conformance for the following:

Receive DICOM Storage SOP Instances from an acquisition modality for long-term data storage.

Service Storage Commitment requests for the SOP Instances.

Send DICOM Storage SOP Instances to an external system for data distribution.

Service and Initiate information query and data retrieval to the Patient, Study, Series, and SOP Instances maintained in another DICOM entity and load them into Cardiology PACS.

Receive a DICOM Modality Worklist information query of the ordered studies from an acquisition modality

Cardiology PACS creates a number of DICOM Application Entities to support these services. Each DICOM AE will be dedicated to a particular type of the DICOM services, as explained in the rest of the document.

1.1 Scope and field of application

The scope of this DICOM Conformance Statement is to facilitate data exchange with Cardiology PACS. This document specifies the compliance of the DICOM standard. It contains a short description of the applications involved and provides technical information about the data exchange capabilities of the equipment. The main elements describing these capabilities are: the supported DICOM Service Object Pair (SOP) Classes, Roles, Information Object Definition (IOD) and Transfer Syntaxes.

1.2 Intended audience

- This Conformance Statement is intended for:
- (Potential) customers,
- System integrators of medical equipment,
- Marketing staff interested in the system functionality,
- Software designers implementing DICOM interfaces.
- It is assumed that the reader is familiar with the DICOM standard.

1.3 Contents and structure

The DICOM Conformance Statement is contained in chapters 2 through 7 and follows the contents and structuring requirements of DICOM PS 3.2-2003.

1.4 Used definitions, terms and abbreviations

DICOM definitions, terms and abbreviations are used throughout this Conformance Statement. For a description of these, see NEMA PS 3.3-2003 and PS3.4-2003.

1.5 References

[DICOM] Digital Imaging and Communications in Medicine (DICOM) standard

NEMA PS 3.X

1.6 Important note to the reader

This Conformance Statement by itself does not guarantee successful interoperability of Cardiology PACS with other vendor equipment. The user (or user's agent) should be aware of the following issues:

1.6.1 Interoperability

Interoperability refers to the ability of the application functions, distributed over two or more systems, to work successfully together. The integration of medical devices into a networked environment may require application functions that are not specified within the scope of DICOM. Consequently, using only the information provided in this Conformance Statement does not guarantee interoperability of Cardiology PACS with other vendor equipment. It is the user's responsibility to analyze thoroughly the application requirements and to specify a solution that integrates Cardiology PACS with other vendor equipment.

1.6.2 Validation

Cardiology PACS has been carefully tested to assure that the actual implementation of the DICOM interface corresponds with the Conformance Statement. Where Cardiology PACS is linked with other vendor equipment, the first step is to compare the relevant Conformance Statements. If the Conformance Statements indicate that successful information exchange should be possible, additional validation tests will be necessary to ensure functionality, performance, accuracy and stability of image and image related data. It is the responsibility of the user (or user's agent) to specify the appropriate test suite and to carry out the additional validation tests.

1.6.3 New versions of the DICOM Standard

The DICOM Standard will evolve in the future to meet the user's growing requirements and to incorporate new features and technologies. Carestream Health is actively involved in this evolution and plans to adapt its equipment to future versions of the DICOM Standard. In order to do so, Carestream Health reserves the right to make changes to its product or to discontinue its delivery. The user should ensure that any other vendor equipment linking to Cardiology PACS, also adapt to future versions of the DICOM standard. If not, the incorporation of DICOM enhancements into Cardiology PACS may lead to loss of connectivity (in case of networking) and the incompatibility (in case of media).

1.7 General Acronyms and abbreviations

ACC	American College of Cardiology
AE	Application Entity
ACR	American College of Radiology
ANSI	American National Standard Institute
BOT	Basic Offset Table
CD-R	CD Recordable
CD-M	CD Medical
DCI	Digital Cardio Imaging
DCR	Digital Cardio Review
DIMSE	DICOM Message Service Element
DIMSE-C	DICOM Message Service Element-Composite
DIMSE-N	DICOM Message Service Element-Normalized
ELE	Explicit VR Little Endian
EBE	Explicit VR Big Endian
FSC	File Set Creator
GUI	Graphical User Interface
HIS	Hospital Information System
HL7	Health Level 7
ILE	Implicit VR Little Endian
IOD	DICOM Information Object Definition
ISIS	Information System – Imaging System
NEMA	National Electrical Manufacturers Association
PDU	Protocol Data Unit
RIS	Radiology Information System
RWA	Real World Activity
SC	Secondary Capture
SCM	Secondary Capture Management
SCP	Service Class Provider
SCU	Service Class User
SOP	Service Object Pair
TCP/IP	Transmission Control Protocol/Internet Protocol
UID	Unique Identifier
WLM	Worklist Management

2 Implementation model

Cardiology PACS is a medical image and information management system designed to provide seamless integration into a healthcare enterprise. Cardiology PACS provides the following DICOM data exchange features:

- It receives images sent to it by remote applications (e.g. imaging modalities or workstations) and stores them in a networked database.
- It allows the operator to send images from the database to remote applications.
- It allows the operator to print images stored in the database on a DICOM printer.
- It is able to read and write DICOM storage media.
- It responds to Worklist queries (patient and study information) by remote applications with Worklist information obtained from an internal database.
- It responds to queries sent by a remote application, retrieves the information queried (if present) and moves it back to the requesting remote application.
- It responds to storage commitment requests from remote applications.
- It responds and is able to process and forward MPPS requests.

Cardiology PACS allows the operator also to view, to analyze and process the images stored in the database. Some advanced analysis and processing applications are primarily designed for images generated by certain imaging modalities and that are sent to Cardiology PACS by means of a private protocol that are beyond the scope of current DICOM standard. Some of these advanced applications may not perform optimally when applied to images that are sent to Cardiology PACS by means of DICOM because additional required data may be lacking.

2.1 Application data flow diagram

Cardiology PACS provides image and non-image data management and archival services. Cardiology PACS consists of multiple independent Application Entities. Its related Implementation model is shown in Figure 2-1.

Cardiology PACS operator can request to send images from Cardiology PACS to a selected remote system, retrieve images from remote systems and can request to print images. This results in Associations initiated by the appropriate AE of Cardiology PACS.

Cardiology PACS is able to reply on verification requests, to store received images onto Cardiology PACS and retrieve requested images from Cardiology PACS. These requests from remote systems are done via Associations initiated by the remote systems.

Cardiology PACS is able to display the contents (i.e. directory listing) of DICOM storage media and to write, read and update images on/from a DICOM storage media.

Cardiology PACS is able to respond to Worklist queries and retrieves the requested Worklist information (patient and study information) from Cardiology PACS database. These requests from remote systems are done via associations initiated by the remote systems.

Cardiology PACS is able to respond to storage commitment requests, to commit the storage of received images onto Cardiology PACS. It then responds with a result of the storage commitment procedure. The request for storage commitment is done via associations initiated by the remote systems.

Cardiology PACS is able to respond to query and retrieve (information objects) requests. Cardiology PACS verifies the presence of the requested object in its database, and if present retrieves it and moves it to the requesting remote application. These requests from the remote systems are done via associations initiated by the remote systems.

Cardiology PACS is also able to receive and forward a DICOM Modality Performed Procedure Step SOP Class N-CREATE request and create a MPPS object within Cardiology PACS. Additionally, Cardiology PACS is able to receive and forward one or more DICOM Modality

Performed Procedure Step SOP Class N-SET requests and update the requested MPPS object within Cardiology PACS.

Figure 2-1: Cardiology PACS Implementation Model
The circles to the left represent the Local
Real World Activities

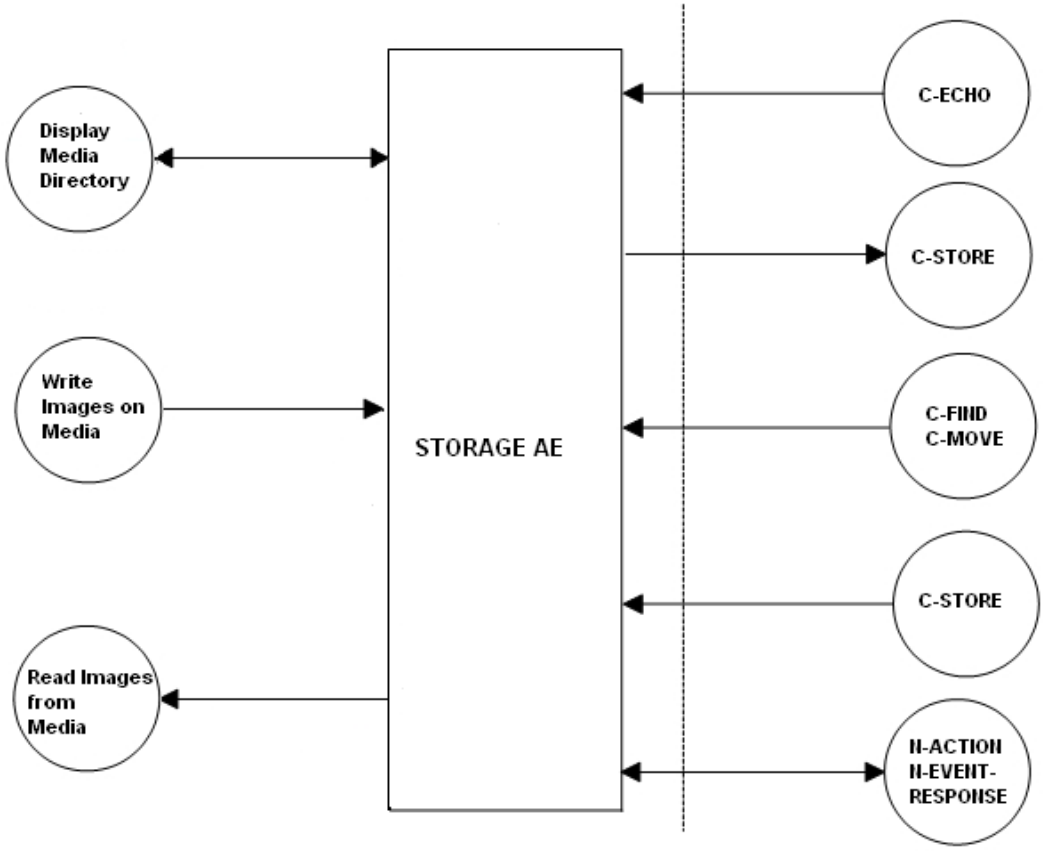

Figure 2-1.1: Cardiology PACS Storage AE Implementation Model

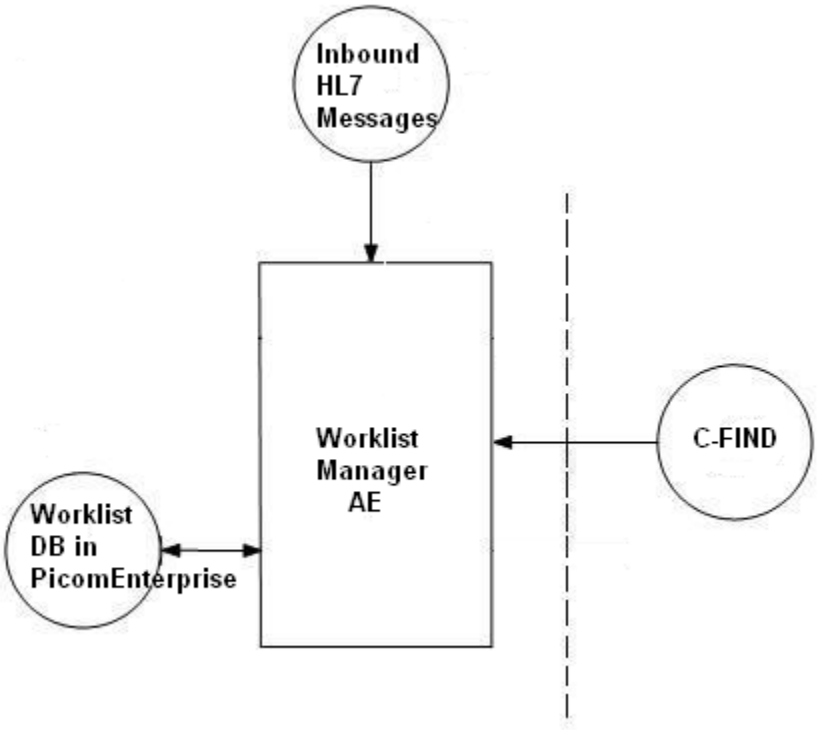

Figure 2-1.2: Cardiology PACS Worklist Manager AE Implementation Model

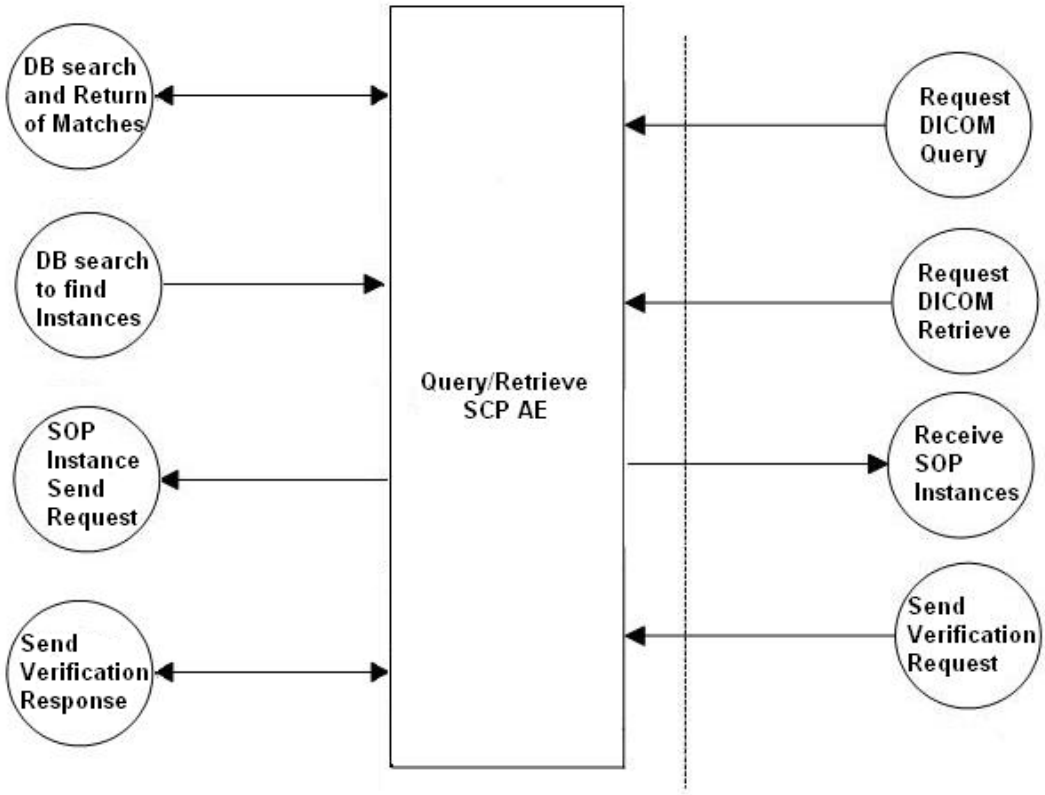

Figure 2-1.3: Cardiology PACS Query/Retrieve Implementation Model

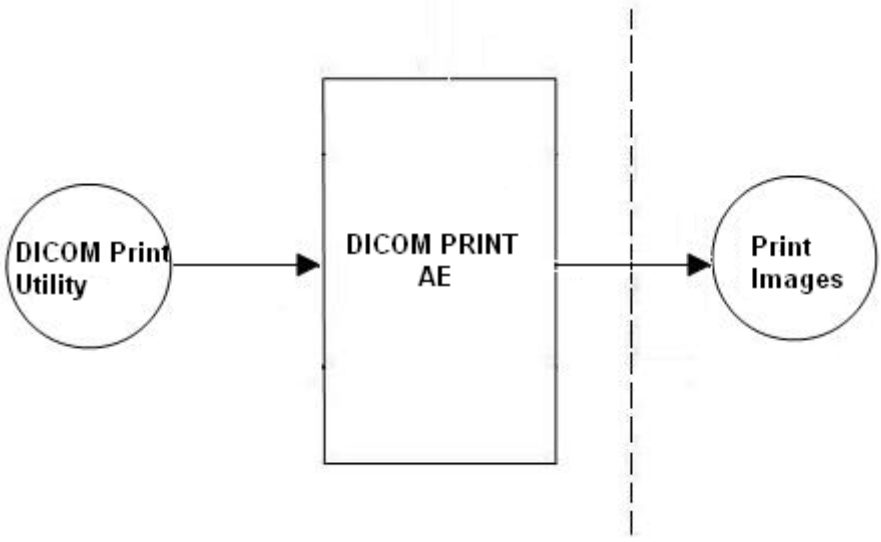

Figure 2-1.4: Cardiology PACS DICOM PRINT AE Implementation Model

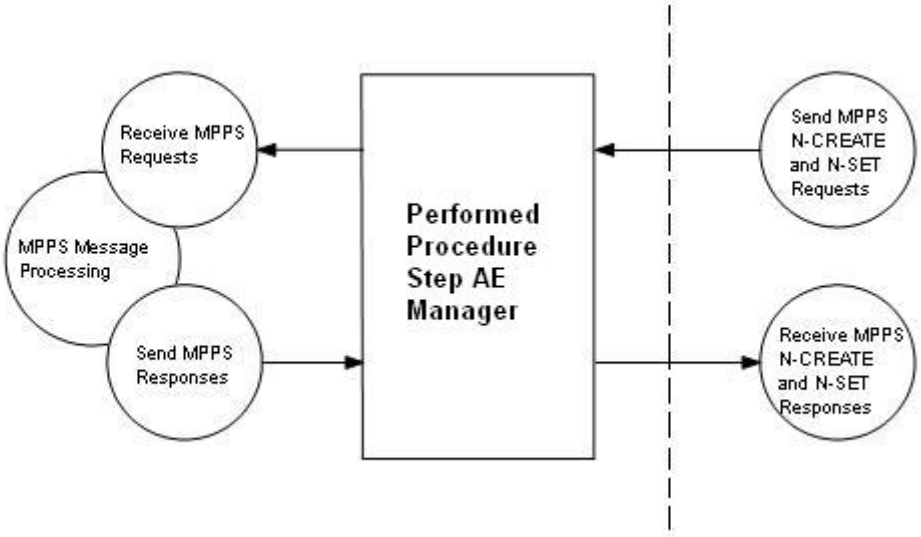

Figure 2-1.5: Cardiology PACS Performed Procedure Step AE Manager Implementation Model

2.2 Functional definition of Application Entities

This implementation provides for simple transfer of images via the DICOM Storage Service Class as a Service Class User (SCU) and a Service Class Provider (SCP).

The NdStoreSCU Application Entity acts as a Service Class User (SCU) of Store service class. The NdStoreSCP acts as a Service Class Provider (SCP) of Verification and Store service classes.

The NdPrintSCU Application Entity acts as a Service Class User (SCU) for the Print Service Class.

The NdWorklistSCP Application Entity acts as a Service Class Provider for the Modality Worklist Service Class.

The NdQueryRetrieveSCP Application entity acts as a Service Class Provider for the Query Retrieve Service Class.

The NdStoreCommitSCP Application Entity acts as a Service Class Provider for the Storage Commitment Service Class.

2.3 Sequencing of Real World Activities

All Real World Activities specified in Figure 2-1 may occur independently from each other, except that the two local Print Real World Activities are mutually exclusive. A request for the printer status is not done when a request for the image printing is busy and vice versa.

3 AE Specifications

The Network capabilities of Cardiology PACS DICOM Application Entities are specified in the section 3.1 and the Media capabilities are specified in section 3.2.

3.1 Storage AE Network Specification

Cardiology PACS Application Entities provide Standard Conformance to the DICOM V3.0 SOP classes as specified in Table 3-1. The following remarks are important:

- The list of available SOP Classes of the full list in Table 3-1 can be configured per Cardiology PACS system at installation time. The SOP Classes to be used can be configured per remote station. See also section 6.2.
- In case the remote system does not support the import of a specific Image Storage SOP Class, Cardiology PACS can convert (if configured to do so) these objects to a suitable format.
- The Private SOP Classes may be stored in image archives but are to be used in Cardiology PACS systems only. See also section 5.

Table 3-1: Supported SOP Classes by the NdStoreSCU AE

SOP Class Name	**Role**	**SOP Class UID**
Verification	SCP	1.2.840.10008.1.1
Computed Radiography Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.1
CT Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.4
Nuclear Medicine Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.20
Ultrasound Image Storage (retired Class)	SCP, SCU	1.2.840.10008.5.1.4.1.1.6
Ulstrasound Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.6.1
Ultrasound Multi-frame Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.3.1
Secondary Image Capture Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.7
X-Ray Angiographic Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.12.1
X-Ray Radiofluoroscopic Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.12.2
RT Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.481.1
Positron Emission Tomography Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.128
Digital X-Ray Image Storage – for presentation	SCP, SCU	1.2.840.10008.5.1.4.1.1.1.1

Table 3-1 (continued): Supported SOP Classes by the NdStoreSCU AE

SOP Class Name	Role	SOP Class UID
Digital X-RAY Image Storage – for processing	SCP,SCU	1.2.840.10008.5.1.4.1.1.1.1.1
Digital Mammography Image Storage – for presentation	SCP, SCU	1.2.840.10008.5.1.4.1.1.1.2
Digital Mammography Image Storage – for processing	SCP, SCU	1.2.840.10008.5.1.4.1.1.1.2.1
Digital Intra-oral X-Ray Image Storage – for presentation	SCP, SCU	1.2.840.10008.5.1.4.1.1.1.3
Digital Intra-oral X-Ray Image Storage – for processing	SCP, SCU	1.2.840.10008.5.1.4.1.1.1.3.1
Grayscale Softcopy Presentation State	SCP, SCU	1.2.840.10008.5.1.4.1.1.11.1
Standalone Curve Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.9
12-lead ECG Waveform Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.9.1.1
General ECG Waveform Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.9.1.2
Ambulatory ECG Waveform Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.9.1.3
Hemodynamic Waveform Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.9.2.1
Cardiac Electrophysiology Waveform Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.9.3.1
Basic Audio Waveform Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.9.4.1
Standard Overlay Image Storage		1.2.840.10008.5.1.4.1.1.8
VL Endoscopic Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.77.1.1
VL Microscopic Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.77.1.2
VL Slide-Coordinates Microscopic Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.77.1.3
VL Photographic Image Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.77.1.4
Hardcopy Color Image Storage	SCP, SCU	1.2.840.10008.5.1.1.30
Raw Data Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.66
Multi-frame Single Bit Secondary Capture	SCP, SCU	1.2.840.10008.5.1.4.1.1.7.1
Multi-frame Grayscale Byte Secondary Capture	SCP, SCU	1.2.840.10008.5.1.4.1.1.7.2

Table 3-1 (continued): Supported SOP Classes by the NdStoreSCU AE

SOP Class Name	Role	SOP Class UID
Multi-frame Grayscale Word Secondary Capture	SCP, SCU	1.2.840.10008.5.1.4.1.1.7.3
Multi-frame True Color Secondary Capture	SCP, SCU	1.2.840.10008.5.1.4.1.1.7.4
Basic Text Structured Report Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.88.11
Enhanced Structured Report Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.88.22
Comprehensive Structured Report Storage	SCP, SCU	1.2.840.10008.5.1.4.1.1.88.33
Key Object Selection Document	SCP, SCU	1.2.840.10008.5.1.4.1.1.88.59
Patient Root Query/Retrieve Information Model – FIND	SCP, SCU	1.2.840.10008.5.1.4.1.2.1.1
Patient Root Query/Retrieve Information Model – MOVE	SCP, SCU	1.2.840.10008.5.1.4.1.2.1.2
Study Root Query/Retrieve Information Model – FIND	SCP, SCU	1.2.840.10008.5.1.4.1.2.2.1
Study Root Query/Retrieve Information Model – MOVE	SCP, SCU	1.2.840.10008.5.1.4.1.2.2.2
Patient/Study Only Query/Retrieve Information Model – FIND	SCP, SCU	1.2.840.10008.5.1.4.1.2.3.1
Patient/Study Only Query/Retrieve Information Model – MOVE	SCP, SCU	1.2.840.10008.5.1.4.1.2.3.2
Storage Commitment Push Model	SCP, SCU	1.2.840.10008.1.20.1
Basic Study Content Notification	SCP	1.2.840.10008.1.9
Modality Worklist Information Model – FIND	SCP	1.2.840.10008.5.1.4.31

3.1.1 Association Establishment Policies

3.1.1.1 General

Cardiology PACS SCU will offer unrestricted max PDU size on Associations initiated by Cardiology PACS itself. This is also configurable per remote station, Cardiology PACS as SCP will offer the same PDU size as offered on Associations initiated by remote applications (SCU), this is not configurable, and will then use that same value as its own PDU size.

3.1.1.2 Asynchronous Nature

The number of simultaneous Associations supported by Cardiology PACS as a Service Class Provider is in principle not limited. The practical maximum number of supported Associations is determined by the amount of resources (CPU, memory, hard disk size).

As a result of local activities, Cardiology PACS will initiate at most 3 simultaneous Associations. One Association is used to issue store requests. The other Association is used to issue retrieve and one for print requests.

Cardiology PACS does not support asynchronous operations and will not perform asynchronous window negotiation.

3.1.1.3 Implementation Identifying Information

The Implementation Class UID ID: 1.3.39.19600601.2.3

The Implementation version name is: NetraDICOM V2.0

3.1.2 Association Initiation Policy

Cardiology PACS initiates Associations as a result of the following events:

- Cardiology PACS operator sends selected images from Cardiology PACS database to another database.
- A remote application sends selected images from a remote database to Cardiology PACS database.
- Cardiology PACS operator requests to print selected images in Cardiology PACS database.

3.1.2.1 Send Images from Cardiology PACS

3.1.2.1.1 Associated Real World Activity

Cardiology PACS can send images pertaining to a selected study in a patient folder from the local Cardiology PACS to another database by means of the DICOM Store tool. Cardiology PACS initiates for each selected study an Association to the selected peer entity and uses it to send C-STORE requests (and receive the associated store replies). The Association is released when all selected images in the folder have been transmitted. Cardiology PACS handles operator send requests one after another.

3.1.2.1.2 Proposed Presentation Contexts

Cardiology PACS will propose the following presentation contexts:

Table –3-3 Proposed Presentation Contexts for Cardiology PACS to Other

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
Name	**UID**	**Name List**	**UID List**		
See Note	See Note	ILE	1.2.840.10008.1.2	SCU	None
See Note	See Note	ELE	1.2.840.10008.1.2.1	SCU	None
See Note	See Note	JPEG Baseline (Process 1)	1.2.840.10008.1.2.4.50	SCU	None
See Note	See Note	JPEG extended (Process 1)	1.2.840.10008.1.2.4.51	SCU	None
See Note	See Note	JPEG Lossless, Non-Hierachial (Process 14)	1.2.840.10008.1.2.4.57	SCU	None
See Note	See Note	JPEG Lossless, Hierarchical, First Order Prediction	1.2.840.10008.1.2.4.70	SCU	None

3.1.2.1.3 C-STORE SCU Conformance

Options:

Extended negotiation is not supported.

Status display and error handling:

The store response status is recorded in the application logs.

Cardiology PACS will stop transferring of the images and release the Association if it receives an unsuccessful or warning store response after three retries. Unsuccessful transfers are placed in a queue and are retried on a FIFO basis for a configurable period of time in the range 1-hour to 6-months.

Generation of new images:

Some Cardiology PACS applications are able to generate new derived images from a set of received (original) images. An example is a 3D reconstructed image from a CT or MR image set. The attributes in these generated images are not specified in this Conformance Statement.

Important remarks about the exported images:

- The images are exported in the status "as seen" in private attributes,
- Cardiology PACS allows the operator to modify attributes of the stored images. Cardiology PACS does not modify the pixel values of the stored images. Modified images retain their original Study, Series and Image UID.
- In case the remote system does not support a modality specific Image Storage SOP Class, Cardiology PACS will convert (if configured to do so) the images and sends them via the SC Image SOP Class. These Secondary Capture images and additional information (like graphics, text and important attribute information) are burnt-in (if configured). The original bit depth of the Secondary Capture image is kept.
- In case of color images, all color-coding schemes are sent out just like they are received. However, the image handling is based on RGB color-coding.

- Images imported into Cardiology PACS via a protocol other than DICOM and then exported via DICOM by Cardiology PACS, will conform as much as possible to the DICOM Conformance Statement of Cardiology PACS.
- Attributes Study Date and Study Time will be added to images to be exported (if not yet present). This is done because there are imaging systems relying on the existence of these attributes.
- The exported Cardiology PACS images do not contain Image Number if the original images received from modalities (possibly via a non-DICOM interface) do not contain this attribute or provide information in other attributes to Cardiology PACS to generate it.
- Exported Cardiology PACS images relate Scanogram and Slice images in the following way:
- Attribute 'Referenced Image Sequence' is present in the slice images and points to the related Scanogram image.
- Note that 'Frame of Reference UID' in the Scanogram (Localizer image) and related image slices are not guaranteed to be equal; this depends on the source of the images.
- The user can add Reference Scanogram/Planscan to slices in the UI of the images that do not have a reference, these will be saved/exported as Reference Image Sequence.
- A number of attributes (e.g. Window Width and Window Center) are formatted as a floating-point numbers.
- For SC images only one Window Width and Window Center value is exported.

Use of optimal, private and retired attributes:

The transmitted Storage SOP instances may include all optional elements specified in the DICOM standard, depending on the source of the images.

The transmitted Storage SOP instances may contain Retired and Private data elements, depending on the source of the images and of Cardiology PACS configuration.

- A private group with group number 7FE1 can be available to store non-standard pixel data behind the 7FE0 group, which contains the standard pixel data.

3.1.2.2 Verification Application Level Communication

3.1.2.2.1 Associated Real World Activity

Cardiology PACS accepts Associations from systems that wish to verify application level communication using the C-ECHO command.

3.1.2.2.2 Presentation Context Table

Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
SOP Class Name	**SOP Class UID**	**Name**	**UID**		
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

3.1.2.2.3 C-ECHO SCP Conformance

Cardiology PACS provides standard conformance.

3.1.2.2.4 Presentation Context Acceptance Criterion

Cardiology PACS accepts all contexts in the intersection of the proposed and acceptable Presentation Contexts. This means that Cardiology PACS accepts multiple proposed Presentation Contexts with the same SOP Class but different transfer Syntaxes.

3.1.2.2.5 Transfer Syntax Selection Policies

Any of the presentation contexts shown in Table 3-3- are acceptable.

3.1.2.3 Store Images in Cardiology PACS Database

3.1.2.3.1 Associated Real World Activity

Cardiology PACS accepts Associations from systems that wish to store images in Cardiology PACS database using the C-STORE command.

3.1.2.3.2 Presentation Context Table

See Table 3-3 for acceptable values.

3.1.2.3.3 C-STORE SCP Conformance

Cardiology PACS provides level 2 (Full) conformance for the Store Service Class. In the event of a successful C-STORE operation, the object is stored into Cardiology PACS database. The duration of storage and further distribution is determined by the way Cardiology PACS is configured.

If Cardiology PACS receives improper DICOM objects, it tries as much as possible (if configured to do so) to fix the tags to conform to DICOM standard. However, Cardiology PACS tries to change objects as little as possible to provide a transparent storage mechanism.

Error Handling:

The C-STORE is unsuccessful if Cardiology PACS returns one of the following codes:

- A700 – Indicates the database is full. Recovery from this condition is left to the Service Class User.
- A900 – Indicates that the SOP class of the image does not match the abstract syntax negotiated for the present context.
- C000 – Indicates that the image cannot be parsed.

Processing of imported images and interoperability:

- Cardiology PACS allows the operator to modify attributes of the stored images. Cardiology PACS does not modify the pixel values of the stored images. Modified images retain their original Study, Series and Image UID.
- The DICOM standard does not guarantee that the advanced Cardiology PACS applications can process the received images. This depends on the presence and consistency of a set of attributes in these images.

3.1.2.3.4 Presentation Context Acceptance Criterion

See section 3.1.3.1.4.

3.1.2.3.5 Transfer Syntax Selection Policies

Any of the Presentation Contexts shown in Table 3-3 are acceptable.

3.1.2.4 Send Modality Worklist Information from Cardiology PACS Database

3.1.2.4.1 Associated Real World Activity

Cardiology PACS accepts associations from remote systems that wish to retrieve Worklist information (patient and study information) from Cardiology PACS database using the C-FIND command.

3.1.2.4.2 Presentation Context Table

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
Modality Worklist Information Model – FIND	1.2.840.10008.5.1.4.31	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

3.1.2.4.3 C-FIND SCP Conformance

The NdWorklist SCP provides Standard conformance to the DICOM Basic Modality Worklist Management Service Class as an SCP.

The attributes that are returned by the NdWorklist SCP to the remote application SCU are configurable. The SCP can decide the attributes to be returned to a particular remote application based on its AE Title. The NdWorklist SCP also limits the number of records returned to 500.

The NdWorklist SCP accepts matching from the Worklist SCU on the following key attributes:

- Scheduled Procedure Step Start Date (0040, 0002).
- The NSWorklist SCP supports the following date query formats:
- Today: Scheduled Procedure Step Start Date (0040, 0002) set to YYYYMMDD, where this date is the current date.
- Days before today and days after today: Scheduled Procedure Step Start Date (0040, 0002) is set to YYYYMMDD-YYYYMMDD, where this date represents the specified number of days before today and/or after today.
- All Days: Scheduled Procedure Step Start Date (0040, 0002) set to zero-length representing universal matching.
- Scheduled Procedure Step Start Time (0040, 0003)
- Patient Last Name (0010, 0010)
- Patient First Name (0010, 0010)
- Patient ID (0010, 0020)
- Accession Number (0008, 0050)

The keys returned by NdWorklist SCP are listed in Table below

Module	Attribute Name	Tag	Notes
Scheduled Procedure Step	Scheduled Procedure Step Sequence	(0040, 0100)	
	>Scheduled Station AE Title	(0040, 0001)	
	> Scheduled Station Name	(0040, 0010)	
	> Scheduled Procedure Step Location	(0040, 0011)	
	>Scheduled Procedure Step Start Date	(0040, 0002)	
	> Scheduled Procedure Step Start Time	(0040, 0003)	
	> Scheduled Procedure Step End Date	(0040, 0004)	
	> Scheduled Procedure Step End Time	(0040, 0005)	
	>Scheduled Performing Physician's Name	(0040, 0006)	
	>Scheduled Procedure Step Description	(0040, 0007)	
	>Scheduled Protocol Sequence	(0040, 0008)	
	>> Code Value	(0008, 0100)	
	>> Coding Scheme Designator	(0008, 0102)	
	>> Coding Scheme Version	(0008, 0103)	
	>> Code Meaning	(0008, 0104)	
	>> Protocol Context Sequence	(0040, 0440)	
	> Scheduled Procedure Step ID	(0040, 0009)	
	> Scheduled Procedure Step Status	(0040, 0020)	
	> Comments on the Scheduled Procedure Step	(0040, 0400)	
	> Modality	(0008, 0060)	
	> Requested Contrast Agent	(0032, 1070)	
	Pre-medication	(0040, 0012)	

Module	Attribute Name	Tag	Notes
Requested Procedure	Requested Procedure ID	(0040, 1001)	
	Reason for Requested Procedure	(0040, 1002)	
	Requested Procedure Comments	(0040, 1400)	
	Requested Procedure Code Sequence	(0032, 1064)	
	> Code Value	(0008, 0100)	
	> Coding Scheme Designator	(0008, 0102)	
	> Coding Scheme Version	(0008, 0103)	
	> Code Meaning	(0008, 0104)	
	Study Instance UID	(0020, 000D)	
	Requested Procedure Description	(0032, 1060)	
	Requested Procedure Priority	(0040, 1003)	
	Requested Procedure Location	(0040, 1005)	
Imaging Service Request	Reason for the Imaging Service Request	(0040, 2001)	
	Imaging Service Request Comments	(0040, 2400)	
	Requesting Physician	(0032, 1032)	
	Referring Physician's Name	(0008, 0090)	
	Accession Number	(0008, 0052)	
Visit Identification	Institution Name	(0008, 0080)	
	Admission ID	(0038, 0010)	
	Issuer of Admission ID	(0038, 0011)	
Patient Identification	Patient's Name	(0010, 0010)	
	Patient ID	(0010, 0020)	
	Issuer of Patient ID	(0010, 0021)	
	Other Patient IDs	(0010, 1000)	
	Other Patient Names	(0010, 1001)	
	Patient's Birth Name	(0010, 1005)	
	Patient's Mother's Birth Name	(0010, 1005)	

Module	Attribute Name	Tag	Notes
Patient Demographic	Patient's Age	(0010, 1010)	
	Occupation	(0010, 2180)	
	Patient's Birth Date	(0010, 0030)	
	Patient's Birth Time	(0010, 0032)	
	Patient's Sex	(0010, 0040)	
	Patient's Insurance Plan Code Sequence	(0010, 0050)	
	> Code Value	(0008, 0100)	
	> Code Scheme Designator	(0008, 0102)	
	> Code Scheme Version	(0008, 0103)	
	> Code Meaning	(0008, 0104)	
	Patient's Size	(0010, 1020)	
	Patient's Weight	(0010, 1030)	
	Patient Address	(0010, 1040)	
	Patient's Country of Residence	(0010, 2150)	
	Patient's Telephone Numbers	(0020, 2154)	
	Patient Comments	(0010, 4000)	
	Ethnic Group	(0010, 2160)	
Patient Medical	Medical Alerts	(0010, 2000)	
	Contrast Allergies	(0010, 2110)	
	Additional Patient History	(0010, 21B0)	
	Pregnancy Status	(0010, 21C0)	
	Special Needs	(0038, 0050)	
	Patient State	(0038, 0500)	

3.1.2.4.4 Presentation Context Acceptance Criterion

No Criterion.

3.1.2.4.5 Transfer Syntax Selection Policies

Only the Implicit VR Little Endian transfer syntax is supported. Any proposed presentation context that does not include the Implicit VR Little Endian transfer syntax will be rejected.

3.1.2.5 Query/Retrieve from Cardiology PACS Database

3.1.2.5.1 Associated Real World Activity

Cardiology PACS accepts associations from remote systems that wish to retrieve images from Cardiology PACS database using the C-MOVE request. A C-MOVE response message will be generated synchronously with the associated C-STORE.

This AE accepts associations for the Image Storage Class using any defined IOD class. It accepts associations for the Query/Retrieve (Q/R) SOP using the Patient Root, Study Root, and Patient/Study Only Query Model.

3.1.2.5.2 Presentation Context Table

Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
SOP Class Name	**SOP Class UID**	**Name**	**UID**		
Patient Root Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP,SCU	None
Patient Root Query/Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None
Study Root Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None
Study Root Query/Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None
Patient Study Only Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.3.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None
Patient Study Only Query/Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.3.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None

In addition, Cardiology PACS Query/Retrieve also supports the following types of attribute matching:

- Single Value Matching
- Universal Matching
- Wild Card Matching
- Range Matching
- List of UID Matching

3.1.2.5.3 C-FIND SCP Conformance

The C-FIND response status values are supported as defined in DICOM c 3.0 Part 4.

All Required (R) and Unique (U) Study, Series, and Image level keys for the Patient Root Study Root and Patient/Study Only Query Retrieve Information Model are supported.

3.1.2.5.4 C-MOVE SCP Conformance

There is no prioritization of C-FIND and C-MOVE requests. All are set to normal – 0.

All images requested in a single C-MOVE will be sent over a single association (the association will not be established and torn down for each image)

3.1.2.5.5 Presentation Context Acceptance Criterion

No Criterion.

3.1.2.5.6 Transfer Syntax Selection Policies

Only the Implicit VR Little Endian transfer syntax is supported. Any proposed presentation context that does not include the Implicit VR Little Endian transfer syntax will be rejected.

3.1.2.5.7 Implementation Remarks

Cardiology PACS Query/Retrieve tool supports Patient Root, Study Root, and Patient-Study Only Information models. The following tables list the information model attributes supported.

3.1.2.5.7.1 Patient Root Query/Retrieve Information Model

3.1.2.5.7.1.1 Patient Level Keys for Patient Root Query/Retrieve Information Model

Attribute Name	Element Tag	Type	Notes
Patient Name	(0010,0010)	Required	
Patient ID	(0010,0020)	Unique	
Patient Birth Date	(0010,0030)	Optional	
Patient Sex	(0010,0040)	Optional	
Other Patient IDs	(0010,1000)	Optional	
Other Patient Names	(0010,1001)	Optional	
Ethnic Group	(0010,2160)	Optional	
Patient Comments	(0010,4000)	Optional	

3.1.2.5.7.1.2 Study Level Keys for Patient Root Query/Retrieve Information Model

Attribute Name	Element Tag	Type	Notes
Study Date	(0008,0020)	Required	
Study Time	(0008,0030)	Required	
Accession Number	(0008,0050)	Optional	
Study ID	(0020,0010)	Required	
Study Instance UID	(0020,000D)	Unique	
Study Description	(0008,1030)	Optional	
Modalities in Study	(0008,0061)	Optional	
Referring Physician	(0009,0090)	Optional	
Study Description	(0008,1030)	Optional	
Patients Age	(0010,1010)	Optional	
Patients Weight	(0010,1030)	Optional	
Study Modality	(0008,0061)	Optional	
Station Name	(0008,1010)	Optional	
Department Name	(0008,1040)	Optional	
Admitting Diagnosis Description	(0008,1080)	Optional	
Patient's Age	(0010,1010)	Optional	
Patient's Size	(0010,1020)	Optional	
Patient's Weight	(0010,1030)	Optional	
Additional Patient History	(0010,21B0)	Optional	

3.1.2.5.7.2 Study Root Query/Retrieve Information Model

3.1.2.5.7.2.1 Study Level Keys for Study Root Query/Retrieve Information Model

Attribute Name	Element Tag	Type	Notes
Patient Name	(0010,0010)	Optional	
Patient ID	(0010,0020)	Optional	
Study Instance UID	(0020,000D)	Unique	
Study Date	(0008,0020)	Required	
Study Time	(0008,0030)	Required	
Study Number	(0020,0010)	Required	(Official: Study ID)
Study Description	(0008,1030)	Optional	
Accession Number	(0008,0050)	Optional	
Referring Physician	(0009,0090)	Optional	
Patients Age	(0010,1010)	Optional	
Patients Weight	(0010,1030)	Optional	
Study Modality	(0008,0061)	Optional	
Station Name	(0008,1010)	Optional	
Department Name	(0008,1040)	Optional	

3.1.2.5.7.3 Patient/Study Only Query/Retrieve Information Model

3.1.2.5.7.3.1 Patient level Keys for Patient/Study Only Query/Retrieve Information Model

See Section 3.1.3.4.7.1.1

3.1.2.5.7.3.2 Study Level Keys for Patient/Study Only Query/Retrieve Information Model

See section 3.1.3.4.7.1.2

3.1.2.5.7.4 Basic Text SR and Enhanced SR C-FIND Supported Attributes

Attribute Name	Element Tag	Type	Notes
SR Instance Specific Level			
Completion Flag	(0040, A491)		
Verification Flag	(0040, A493)		
Content Date	(0008, 0023)		
Content Time	(0008, 0033)		
Observation Date Time	(0040, A032)		
Verifying Observer Sequence	(0040, A032)		
>Verifying Organization	(0040, A027)		
>Verification Observer Name	(0040, A075)		
>Verifying Observer Indentification Code	(0040, A088)		
Referenced Request Sequence	(0040, A370)		
>Study Instance UID	(0020, 000D)		
>Accession Number	(0008, 0050)		
>Requested Procedure ID	(0040, 1000)		
>Requested Procedure Code Sequence	(0032, 1064)		
>>Code Value	(0008, 0100)		
>>Code Scheme Designator	(0008, 0102)		
>>Code Scheme Version	(0008, 0103)		
>>Code Meaning	(0008, 0104)		
Concept Name Code Sequence	(0008, 0102)		
>Code Value	(0008, 0100)		
>Code Scheme Designator	(0008, 0102)		
>Code Scheme Version	(0008, 0103)		
>Code Meaning	(0008, 0104)		

3.1.2.5.7.5 Grayscale Soft Copy Presentation State C-FIND Supported Attributes

Attribute Name	Element Tag	Type	Notes
GSPS Instance Specific Level			
Presentation Label	(0070, 0080)		
Presentation Description	(0070, 0081)		
Presentation Creation Date	(0070, 0082)		
Presentation Creation Time	(0070, 0083)		
Presentation Creator's Name	(0070, 0084)		
Referenced Series Sequence	(0008, 1115)		
>Series Instance UID	(0020, 000E)		
>Referenced Image Sequence	(0008, 1140)		
>> Referenced SOP Class UID	(0008, 1150)		
>> Referenced SOP Instance UID	(0008, 1155)		

3.1.2.6 Response to Storage Commitment Request

3.1.2.6.1 Associated Real World Activity

The associated real world activity is the receipt of a Storage Commitment request from a remote application entity. When Cardiology PACS receives a storage commitment request (N-ACTION) it will immediately respond with a status of success. It will then try to locate all objects (SOP instances) for which storage commitment was requested. Once the objects are located, it will

establish an association back to the requesting entity and will send a storage commitment response (N-EVENT-REPORT). The association will be closed after completion of the N-EVENT-REPORT.

3.1.2.6.2 Presentation Context Table

Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
SOP Class Name	**SOP Class UID**	**Name**	**UID**		
Storage Commitment Push Model	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None

3.1.2.6.3 SOP Specific Conformance for Storage Commitment Push SOP Class

Cardiology PACS Storage Commitment tool conforms fully to the SOP of the Storage Commitment Push Service Class. No extended negotiation is supported.

If Cardiology PACS returns one of the following status codes for N-ACTION, then the request for storage commitment was unsuccessful.

0119 (Class-instance conflict) – Indicates that the SOP instance UID sent in the N-ACTION-RQ did not match the Storage Commitment Push Model SOP Instance UID (1.2.840.10008.1.20.1.1)

0110 (Processing Failure) – Indicates that an unknown error occurred during the storage commitment.

3.1.2.6.4 Presentation Context Acceptance Criterion

No Criterion.

3.1.2.6.5 Transfer Syntax Selection Policies

Only the Implicit VR Little Endian transfer syntax is supported. Any proposed presentation context that does not include the Implicit VR Little Endian transfer syntax will be rejected.

3.1.2.7 Send Basic Study Content Notification to a Remote System

3.1.2.7.1 Associated Real World Activity

Cardiology PACS accepts associations from nodes which want it to be notified about studies that have been performed by other application entities. The application entity performing a study content notification sends a C-STORE request to Cardiology PACS. The C-STORE request specifies the content of a study that has been performed. Cardiology PACS checks all series and images it is notified about and sends the C-STORE response message containing one of the following status values: complete study content exists, partial study content exists or none of the study content exists on the system supporting Cardiology PACS.

3.1.2.7.2 Proposed Presentation Contexts

Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
SOP Class Name	**SOP Class UID**	**Name**	**UID**		
Basic Study Content Notification	1.2.840.10008.1.9	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

3.1.2.7.3 SOP Specific Conformance

Cardiology PACS does not try to retrieve images, series or studies which don't exist on its system.

3.1.2.7.4 Presentation Context Acceptance Criterion

No Criterion.

3.1.2.7.5 Transfer Syntax Selection Policies

Only the Implicit VR Little Endian transfer syntax is supported. Any proposed presentation context that does not include the Implicit VR Little Endian transfer syntax will be rejected.

3.1.2.8 Print Images

3.1.2.8.1 Associated Real World Activity

The operator can select one or more images from the initial database (via the Data Handling Facility) and perform a print operation on them. The operator will select the print destination from a list of configured printers and some print parameters (depending on the configuration and the selected printer).

As a result, Cardiology PACS will initiate an association to the selected printer and uses it to send the Print Service Elements of the Print SOP Classes.

3.1.2.8.2 Proposed Presentation Contexts

Cardiology PACS will propose the presentation contexts as given in Table 3-3.

3.1.2.8.3 Conformance to the Print SOP Classes

Cardiology PACS provides standard conformance to the Basic Grayscale Print Management Meta SOP Class.

The application order of Print Service Elements (DIMSE's) is specified in Table 3-4. A description and the applied optional (i.e. non-mandatory attributes as Print SCU) attributes in these Services Elements are specified too. Note that the Service elements order is not specified by the DICOM standard.

Cardiology PACS does not do an explicit N-DELETE Request on the created instances; these are deleted implicitly when releasing the association.

Overlay, Annotation (showing the values of some major identifying attributes) and Shutter Information is processed in the images sent to the printer (i.e. burnt-in image).

The full list of (Mandatory and Optional) attributes applied in these Service Elements is given in section 8.

Table 3-4: The applied order of Print Service Elements and its optional attributes

Service Element of SOP Class	Note
N-GNET of the Printer SOP Class	Purpose is to retrieve printer information
N-CREATE of the Basic Film Session SOP Class	Cardiology PACS specifies the DICOM Printer about some general presentation parameters, applicable for all films in the Film Session. Applied optional attributes are: Number of Copies, Print Priority, Medium Type, Film Destination
N-CREATE of the Basic Film Box SOP Class	Cardiology PACS specifies the DICOM Printer about some general presentation parameters, applicable for all images in the Film Box. Applied optional attributes are: Film Orientation, Film Size ID, Magnification Type, Max. Density, Configuration Information, Trim
N-SET of the Basis Grayscale/Color Image Box SOP Class	Cardiology PACS will send images to be printed. Applied optional attributes are: Polarity
N-ACTION of the Basic Film Box SOP Class	Cardiology PACS triggers the DICOM Printer to print, this actual print action is done at film box level. No (optional) attributes are present.

The table below specifies the supported Service Elements, which may be generated by the Printer at any time during the association.

Table 3-5: The applied sequence of Print Service Elements and its optional attributes

Service Element of SOP Class	Note
N-EVENT-REPORT of the Printer SOP Class	May be sent at any moment by the Printer SCP (i.e. DICOM Printer). Cardiology PACS will ignore the contents of these events. However, the printer status is polled via a separate association, see section 3.1.2.5

The Status Codes of DIMSE Responses (Success, Warning, Failure) as returned by the printer will also be logged (for service purposes) and are mapped onto general print job status messages towards the operator.

The user Interface message indicates:

- "Job Completed" and has the meaning that the print job is accepted by the printer; the actual printing will be done afterwards.
- "General Print Error" indicating that a failure occurred during the DICOM Print. Also, most warning cases (like default printer values applied optimal print attributes) are interpreted as a print error because this will mostly result in a different print quality or print layout than expected.

The following implementation remarks are important to achieve successful printing:

- Cardiology PACS will release the association when the print command is given (i.e. the N-ACTION Requests); the association is not kept open for receiving N-EVENT-REPORTs of the Printer SOP Class.
- On status-errors/warnings in a DIMSE response, the data transfer will be stopped and film will not be printed.

3.1.3 Association Acceptance Policy

Cardiology PACS accepts Associations for the following purposes:

- To allow remote applications to verify application level communication with Cardiology PACS.
- To allow remote applications to store images in Cardiology PACS database (i.e. image import).

Cardiology PACS Application Entity (if configured to do so) rejects Association requests from unknown applications, i.e., applications that offer an unknown "calling AE title". An application is known if and only if it is defined during configuration of Cardiology PACS.

Any of the presentation contexts shown in Table 3-3 are acceptable.

3.2 Performed Procedure Step Manager Specification

3.2.1 Association Establishment Policies

3.2.1.1 General

The Performed Procedure Step Manager functions as a standalone application entity. The Performed Procedure Step N-CREATE message is sent automatically after the acquisition protocol has been selected, and before the acquisition is begun. There is no operator intervention required.

The Performed Procedure Step N-SET message is sent immediately after the acquisition has completed. If the operator aborted the acquisition, a DISCONTINUED status is sent, and no intervention by the operator is needed. In all other cases, the status that is sent is COMPLETED.

The PPS manager immediately and reliably distributes PPS information from the Acquisition Modality Actor or Image Creator Actor to both the Image Manager and the Department System Scheduler/Order Filler. If transmission to one or both destinations fails, the PPS manager tries to repeat the transmission periodically until it succeeds or until a specified time limit for transmission is exceeded. The PPS Manager's reliable delivery service has configurable parameters, including maximum number of attempted re-transmissions and delay between re-transmissions.

3.2.1.2 Number of Associations

The PPS Manager will attempt one association establishment per N-Set or N-Create message received to the remote configured destination. The PPS Manager will accept any number of simultaneous associations, the number of which can be configured.

3.2.1.3 Asynchronous Nature

There is no asynchronous activity in this implementation.

3.2.1.4 Implementation Identifying Information

The Implementation Class UID ID: 1.3.39.19600601.2.2

The Implementation version name is: NetraDICOM V2.0

3.2.2 Association Initiation Policy

The Performed Procedure Step software attempts to initiate an association once each time it is invoked.

3.2.2.1.1 Forwarding MPPS Messages

3.2.2.1.2 Associated Real-World Activity

The Performed Procedure Step software attempts to initiate an association once each time it is invoked. There is only one Real World Activity that can cause association establishment: initiating and completing an acquisition. To prevent a potential infinite redistribution of PPS messages, the PPS Manager provides a configuration mechanism that can enable and disable the Performed Procedure Step Manager component.

The MPPS SCP can optionally forward all received N-SET and N-CREATE messages to a second MPPS SCP. The MPPS DICOM service then appears as an MPPS SCU.

All received N-CREATE and N-SET messages are forwarded as they were received. The message is forwarded using the same presentation context negotiated when the originating modality performed the association with the MPPS SCP.

3.2.2.1.3 Proposed Presentation Contexts

The PPS Manager will propose the following Transfer Syntaxes for each presentation context in an association it initiates:

Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
SOP Class Name	**SOP Class UID**	**Name**	**UID**		
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None

Table 3-2: Supported SOP Classes by the Performed Procedure Step Manager

3.2.3 Association Acceptance Policy

When the PPS Manager accepts an association, it will allow the storage MPPS messages and the verification of the Application Entity.

The PPS Manager is configurable to allow security restrictions ranging from promiscuous to limiting a particular remote application entity to specified SOP classes and specified SCU/SCP roles. If security is turned on, association attempts by unknown entities will be rejected outright and proposed presentation contexts from known remote application entities may be rejected.

3.2.3.1 Respond to a Verification Request from a Remote System

3.2.3.1.1 Associated Real-World Activity

The Performed Procedure will respond with a status of successful if it receives a verification request.

3.2.3.1.2 Presentation Context Table

The PPS Manager will accept the following Transfer Syntaxes for each presentation context in an association it receives:

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
SOP Class Name	**SOP Class UID**	**Name**	**UID**		
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

3.2.3.1.3 SOP Specific Conformance for Verification SOP Class

The PPS Manager conforms to the SOP of the Verification Service Class fully. The Performed Procedure Step software does not attempt any extended negotiation. If the PPS Manager returns anything other than success, then the C-ECHO operation failed.

3.2.3.2 Receiving MPPS Messages

3.2.3.2.1 Associated Real-World Activity

The PPS manager receives an N-Create or N-Set operation; it will process it accordingly and respond with a status of Success to the MPPS SCU. The received message will then be forwarded reliably to the remote configured MPPS SCP. For this operation the PPS manager is serving the role of the MPPS SCU.

3.2.3.2.2 Presentation Context Table

The PPS Manager will accept the following Transfer Syntaxes for each presentation context in an association it receives:

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
SOP Class Name	**SOP Class UID**	**Name**	**UID**		
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCP, SCU	None

3.2.3.2.3 SOP Specific Conformance Statement for MPPS

The PPS Manager provides standard conformance to the DICOM Modality Performed Procedure Step SOP Class as an SCP.

3.2.3.2.4 Presentation Context Acceptance Criterion

No Criterion.

3.2.3.2.5 Transfer Syntax Selection Policies

The PPS Manager only supports the Implicit VR Little Endian transfer syntax. Any proposed presentation context that does not include the Implicit VR Little Endian transfer syntax will be rejected.

3.3 Media Storage AE Specification

The NdStoreMedia AE provides Standard Conformance to the DICOM Media Storage Service and File Format (PS 3.10) and the Media Storage Application Profiles (PS 3.11) as far as reading of uncompressed images on DICOM Storage Media is concerned.

3.3.1 File Meta Information

The (Source) Application Entity Title is specified in section 3.1.1.4. The Implementation Class UID and the Implementation Version Name in the File Meta Header is specified in section 3.1.1.4.

3.3.2 Media Related Real World Activities

3.3.2.1 RWA Display Directory

The NdStoreMedia AE will act as a FSR when reading the directory of the medium. This will result in an overview of the patients, studies, series and images on Cardiology PACS screen.

Implementation restriction:

- Cardiology PACS is not guaranteed to display the directory listing of DICOM Storage media on which the data is pressed by the disk producer (like is the case with software CD's).

3.3.2.1.1 Application Profile(s) for this RWA

See Table 3-7.

3.3.2.1.2 Required and Optional DICOMDIR Keys

The Mandatory DICOMDIR Keys are required for the correct display of Directory Information. The display is structured according to the DICOM Composite Information Model: Patient, Possibly present optional DICOMDIR Keys are not displayed.

3.3.2.2 RWA Write Images to DICOM Storage Media

The NdStoreMedia AE will act as a FSC when writing all/selected images in a patient folder onto the DICOM Storage media. Note that the images are written in ELE (by default), so are compressed, as specified in the STD-GEN-CD Application Profile. Other Presentation contexts are configurable.

3.3.2.2.1 Application Profile(s) for this RWA

See Table 3-7.

3.3.2.2.2 RWA Write Images to DICOM Storage media

The same remarks as section 3.1.2.1 about the existence of Optional, Retired and Private attributes are applicable. The DICOMDIR file will be extended when new images are written. In case some attributes are not present in the images but are specified Mandatory in the DICOMDIR definition in the DICOM Media, a dummy ID will be filled in.

Implementation Remarks:

When writing the DICOMDIR records, the key's values are generated when no value of the corresponding attribute is supplied:

- PATIENT_ID
- STUDY_ID
- STUDY_INSTANCE_UID
- SERIES_NUMBER
- SERIES_INSTANCE_UID
- IMAGE_NUMBER
- SOP_INSTANCE_UID

- The mechanism of generating a value for PATIENT_ID creates each time a new value based on PATIENT_NAME for each new study for the DICOM Storage media, even if the study belongs to a patient recorded earlier.
- The default value for the Pixel Intensity Relationship (0028, 1040) is set to DISP.
- A number of attributes (e.g. Window Width and Window Center) can be formatted as floating point numbers.

3.3.2.3 RWA Read Images from DICOM Storage media

Cardiology PACS AE will act as a FSR when reading all/selected images from the DICOM Storage media.

Implementation remarks and restrictions:

- Cardiology PACS is also able to read images coded in all of the JPEG codes as specified in Table 3-3, {Proposed Presentation Contexts for Cardiology PACS to Other".
- For the CD-Medical medium only the standard XA STILL file is being read, the non-standard XA MOVIE files are not accessible.

3.3.2.3.1 Application Profile(s) for this RWA

See Table 3-7.

3.3.2.3.2 Support for attributes in images

The Mandatory attribute of the DICOM images is required for the correct storage of the images in Cardiology PACS internal image database. Optional Attributes and Retired/Private Attributes are stored too if present; this is equivalent with the level 2 (Full) conformance for the Storage Service Class in the Network support, see section 3.1.3.2.

The same remarks as in section 3.1.3.2.3 about that storage of multi-frame/Bi-plane images and about requirements to process read images via the dedicated Cardiology PACS application functions, are applicable.

3.3.3 Augmented Application Profile

Cardiology PACS supports all transfer syntaxes as mentioned in Table 3-3.

Instances of the Private SOP Classes (see Table 3-1) may be written on the DICOM Storage media.

4 Communication Profiles

4.1 Supported Communication Stacks

Cardiology PACS application provides DICOM V3.0 TCP/IP Network Communication Support as defined in Part 8 of the DICOM standard.

4.2 TCP/IP Stack

Cardiology PACS inherits its TCP/IP stack from the IBM compatible system upon which it executes.

4.2.1 Physical Media Support

Ethernet ISO 8802-3. Standard AUI, optional twisted pair 10-BaseT.

5 Extensions/Specializations/Privatizations

The standard DICOM SOP Classes may be extended with additional attributes:

- Standard attributes of the SOP Classes; the presence of these attributes in exported images can be configured, see section 6.2.
- Retired (from ACR NEMA 1.0 or 2.0) attributes; the presence of these attributes in exported images can be configured, see section 6.2.
- Private attributes; the presence of these attributes in exported images can be configured, see section 6.2.

There are no Specialized SOP Classes.

6 Configuration

Cardiology PACS is configured by means of a configuration program. This program is accessible at the startup of Cardiology PACS. It is intended to be used by Carestream Health Customer Support Engineers only. This program prompts the Customer Support Engineer to enter configuration information needed for Cardiology PACS application.

6.1 AE Title/Presentation Address mapping

6.1.1 Local AE Titles and Presentation Addresses

Cardiology PACS AE title is default equal to the IP host name. This host name can be changed by the Customer Support Engineer at installation.

6.1.2 Remote AE Titles and Presentation Addresses

All relevant remote applications able to setup a DICOM Association towards Cardiology PACS must be configured at Cardiology PACS configuration time. The Customer Support Engineer must provide the following information for each application:

- The Application Entity Title
- The SOP classes and Transfer Syntaxes for which Cardiology PACS accepts Associations.
- All relevant remote applications able to accept DICOM Associations from Cardiology PACS must be configured at Cardiology PACS configuration time. The Customer Support Engineer must provide the following information for each remote application:
- The Application Entity Title
- The host name/IP address on which the remote application resides.
- The port number at which the remote application accepts Association requests.

6.2 Configurable parameters

6.2.1 Configurable per Cardiology PACS system

The following items are configurable per Cardiology PACS installation:

- The SOP classes (out of the full list of SOP Classes in Table 3-1 and Table 3-2) and the Transfer Syntaxes (out of the full list in Presentation Context Tables in this statement) to be used.
- The maximum PDU size for associations initiated by Cardiology PACS (default is 0 meaning unlimited PDU size).

6.2.2 Configuration per remote system

The following items are configurable per remote system:

- The SOP classes and Transfer Syntaxes for which Cardiology PACS sets-up and accepts associations.
- Automatic conversion of images of SOP classes not supported by remote systems into SC Image Storage SOP instances.
- The maximum PDU size for Associations initiated by Cardiology PACS.
- Export of ‘pure’ DICOM images (i.e. only the standard DICOM attributes defined in the related IOD) or ‘rich’ DICOM images (with additional Standard DICOM, Private and Retired attributes).

6.2.3 Print Configuration

Configurable per Cardiology PACS installation:

- The DICOM printers to be selected by the operator.

The following print parameters are configurable per DICOM printer type (see also the Print Management overview if the supported attributes in section 8):

- The Medium Type
- Film Size ID (i.e. Media Size)
- Film Orientation
- Image Display Format
- Film Size in X and Y direction (this influences the Rows and Columns in the Image Box instances).
- Configuration Information (configurable per print destination). This is a character string containing implementation specific print parameters.
- Magnification Type.
- Trim.
- Film Destination.
- Max. Density.

These print parameters can be selected from choice lists. These choice lists are defined via so-called protocols for each type of printer and print medium. These prototypes are also configurable.

7 Support of Extended Character Sets

Cardiology PACS supports Extended Character Set "ISO_IR 100" which is the Latin alphabet No 1, supplementary set.

8 Overview of the applied Print Management Service Elements

8.1 Basic Film Session SOP Class

Table 8-1: Basic Film Session SOP Class – N-CREATE

Attribute Name	Tag	Note
Number of Copies	2000,0010	Between 1 and 99
Print Priority	2000,0020	Applied value(s): MED, HIGH
Medium Type	2000,0030	Applied value(s): BLUE FILM, CLEAR FILM, PAPER
Film Destination	2000,0040	Applied value(s): MAGAZINE, PROCESSOR

8.2 Basic Film Box SOP

Table 8-2; Basic Film Box SOP Class – N-CREATE

Attribute Name	Tag	Note
Image Display Format	2010,0010	The applied value is below a Cardiology PACS specific value indicating that one (large) image is contained in a Film Box. Applied value(s): CUSTOM\1, STANDARD\1,1 (1 is a vendor specific index, i.e. an integer) is applied in the Standard Image Display Format does not result in acceptable films. Purpose of this value is to use the film surface as much as possible for image printing (and avoid large margins). This should be agreed per printer vendor.
Film Orientation	2010,0040	Applied value(s): LANDSCAPE, PORTRAIT
Film Size ID	2010,0050	DICOM specifies a number of Defined Terms; more values are possible and are print configuration dependent.
Magnification Type	2010,0060	Normally sent out, however sometimes sent out empty because some DICOM printers and not able to handle (value NONE for) this attribute. Applied value(s): NONE
Trim	2010,0140	
Configuration Information	2010,0150	Contains a vendor specific Lookup Table (LUT); should be applied by the DICOM printer if LUT data is present.

Table 8-3: Basic Film Session SOP Class – Basic Film Box Relationship Module

Attribute Name	Tag	Note
Referenced Film Session Sequence	2010,0500	Parent Film Session
>Reference SOP Class UID	0008,1150	
>Referenced SOP Instance UID	0008,1155	

Table 8-4: Basic Film Session SOP Class – N-ACTION

Attribute Name	Tag	Note
No attributes present		

8.3 Basic Grayscale Image Box SOP class

Table 8-5: Basic Grayscale Image SOP Class – N-SET

Attribute Name	Tag	Note
Image Position	2020,0010	Applied value(s): 1
Polarity	2020,0020	Applied value(s): NORMAL
Preformatted Grayscale Image Sequence	2020,0110	
>Samples per Pixel	0028,0002	Applied value(s): 1
>Photometric Interpretation	0028,0004	Applied value(s): MONOCHROME2
>Rows	0028,0010	Depending on the selected printer type and film size
>Columns	0028,0011	Depending on the selected printer type and film size
>Bits Allocated	0028,0100	Applied value(s): 16,8
>Bits Stored	0028,0101	Applied value(s): 12,8
>High Bit	0028,0102	Applied value(s): 11,7
>Pixel Representation	0028,0103	Applied value(s): 0x0000
>Pixel Data UID	7FE0,0010	

8.4 Color Grayscale Image Box SOP Class

Table 8-6: Basic Color Image Box SOP Class – Image Box Pixel Presentation Module

Attribute Name	Tag	Note
Image Position	2020,0010	Applied value(s): 1
Polarity	2020,0020	Applied value(s): NORMAL
Preformatted Grayscale Image Sequence	2020,0111	
>Samples per Pixel	0028,0002	Applied value(s): 3
>Photometric Interpretation	0028,0004	Applied value(s): RGB
>Planar Interpretation	0028.0006	Applied value(s): 0000,0001 0000, is not interleaved, 0001, frame interleaved
>Rows	0028,0010	
>Columns	0028,0011	Depending on the selected printer type and film size
>Bits Allocated	0028,0100	Applied value(s): 8
>Bits Stored	0028,0101	Applied value(s): 8
>High Bit	0028,0102	Applied value(s): 7
>Pixel Representation	0028,0103	Applied value(s): 0x0000
>Pixel Data UID	7FE0,0010	

Table 8-7: Printer SOP Class – N-GET

Attribute Name	Tag	Note
Printer Status	2110.0010	
Printer Status Info	2110,0020	

Table 8-8: Printer SOP Class – N-EVENT-REPORT

Attribute Name	Tag	Note
Printer Status Info	2110,0020	Conditionally sent by the Printer. Cardiology PACS will ignore the status information. However, polling this status via the N-GET Service Element is done.

The Service Element is sent by the printer and interpreted by Cardiology PACS.

Cardiology PACS does not send an attribute to the printer, therefore the only attributes which are needed to be supported by the printer, are the mandatory attributes listed in Table 8-7, "Printer SOP Class – N-GET".