DICOM Conformance Statement for Progeny Imaging, rev. 1.6

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OVERVIEW

Midmark Progeny Imaging is software designed to facilitate the acquisition, analysis, and organization of digital images and documents with main area of application in Dentistry. It supports intraoral radiographic sensors, photo-, video cameras, and other external image sources. The Progeny Imaging is GUI-based and runs on a Windows XP/Vista 32-bit, and 64-bit platforms.

The DICOM functionality of Progeny Imaging consists of a DICOM Storage SCU that allows sharing of the internally stored images with other digital imaging systems such as a Picture Archiving and Communication System (PACS).

The table of the supported network services is provided on Table 1, page 2. No media services are provided.

Table 1: Network Services

SOP Classes	User of Service (SCU)	Provider of Service (SCP)
Transfer		
Digital Intra-oral X-Ray Image Storage – For Presentation	Yes	No

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1. INTRODUCTION

1.1. REVISION HISTORY

Document Version	Revision Date	Revision Author	Revision Description
1.0	March 9, 2007	DW	Final text for Progeny Imaging rev. 1.1.4.3
A	May 27, 2009	LLC, BAM	Final text for Progeny Imaging rev. 1.6

1.2. AUDIENCE

This document is written for the people that need to understand how Progeny Imaging will integrate into their healthcare facility. This includes both those responsible for overall imaging network policy and architecture, as well as integrators who need to have a detailed understanding of the DICOM features of the product. This document contains some basic DICOM definitions so that any reader may understand how this product implements DICOM features. However, integrators are expected to fully understand all the DICOM terminology, how the tables in this document relate to the product's functionality, and how that functionality integrates with other devices that support compatible DICOM features.

1.3. REMARKS

The scope of this DICOM Conformance Statement is to facilitate integration between Progeny Imaging and other DICOM products. The Conformance Statement should be read and understood in conjunction with the DICOM Standard. DICOM by itself does not guarantee interoperability. The Conformance Statement does, however, facilitate a first-level comparison for interoperability between different applications supporting compatible DICOM functionality.

This Conformance Statement is not supposed to replace validation with other DICOM equipment to ensure proper exchange of intended information. In fact, the user should be aware of the following important issues:

- The comparison of different Conformance Statements is just the first step towards assessing interconnectivity and interoperability between the product and other DICOM conformant equipment.
- Test procedures should be defined and executed to validate the required level of interoperability with specific compatible DICOM equipment, as established by the healthcare facility.

1.4. TERMS AND DEFINITIONS

Informal definitions are provided for the following terms used in this Conformance Statement. The DICOM Standard is the authoritative source for formal definitions of these terms.

Abstract Syntax – the information agreed to be exchanged between applications, generally equivalent to a Service/Object Pair (SOP) Class. Examples: Verification SOP Class, Modality Worklist Information Model Find SOP Class, Computed Radiography Image Storage SOP Class.

Application Entity (AE) – an end point of a DICOM information exchange, including the DICOM network or media interface software; i.e., the software that sends or receives DICOM information objects or messages. A single device may have multiple Application Entities.

Application Entity Title – the externally known name of an Application Entity, used to identify a DICOM application to other DICOM applications on the network.

Application Context – the specification of the type of communication used between Application Entities. Example: DICOM network protocol.

Association – a network communication channel set up between Application Entities.

Attribute – a unit of information in an object definition; a data element identified by a tag. The information may be a complex data structure (Sequence), itself composed of lower level data elements. Examples: Patient ID (0010, 0020), Accession Number (0008, 0050), Photometric Interpretation (0028,0004), Procedure Code Sequence (0008, 1032).

Information Object Definition (IOD) – the specified set of Attributes that comprise a type of data object; does not represent a specific instance of the data object, but rather a class of similar data objects that have the same properties. The Attributes may be specified as Mandatory (Type 1), Required but possibly unknown (Type 2), or Optional (Type 3), and there may be conditions associated with the use of an Attribute (Types 1C and 2C). Examples: Magnetic Resonance Image IOD, Print Job IOD.

Media Application Profile – the specification of DICOM information objects and encoding exchanged on removable media (e.g., CDs)

Module – a set of Attributes within an Information Object Definition that are logically related to each other. Example: Patient Module includes Patient Name, Patient ID, Patient Birth Date, and Patient Sex.

Negotiation – first phase of Association establishment that allows Application Entities to agree on the types of data to be exchanged and how that data will be encoded.

Presentation Context – the set of DICOM network services used over an Association, as negotiated between Application Entities; includes Abstract Syntaxes and Transfer Syntaxes.

Protocol Data Unit (PDU) – a packet (piece) of a DICOM message sent across the network. Devices must specify the maximum size packet they can receive for DICOM messages.

Security Profile – a set of mechanisms, such as encryption, user authentication, or digital signatures, used by an Application Entity to ensure confidentiality, integrity, and/or availability of exchanged DICOM data

Service Class Provider (SCP) – role of an Application Entity that provides a DICOM network service; typically, a server that performs operations requested by another Application Entity (Service Class User). Examples: Picture Archiving and Communication System (image storage SCP, and image query/retrieve SCP), Radiology Information System (modality worklist SCP).

Service Class User (SCU) – role of an Application Entity that uses a DICOM network service; typically, a client. Examples: imaging modality (image storage SCU, and modality worklist SCU), imaging workstation (image query/retrieve SCU)

Service/Object Pair Class – the specification of the network or media transfer (service) of a particular type of data (object); the fundamental unit of DICOM interoperability specification. Examples: Ultrasound Image Storage Service, Basic Grayscale Print Management.

Service/Object Pair Instance – an information object; a specific occurrence of information exchanged in a SOP Class. Examples: a specific X-Ray image.

Tag – a 32-bit identifier for a data element, represented as a pair of four digit hexadecimal numbers, the "group" and the "element". If the "group" number is odd, the tag is for a private (manufacturer-specific) data element. Examples: (0010, 0020) [Patient ID], (07FE, 0010) [Pixel Data], (0019, 0210) [private data element]

Transfer Syntax – the encoding used for exchange of DICOM information objects and messages. Examples: JPEG compressed (images), little endian explicit value representation.

Unique Identifier (UID) – a globally unique "dotted decimal" string that identifies a specific object or a class of objects; an ISO-8824 Object Identifier. Examples: Study Instance UID, SOP Class UID, SOP Instance UID.

Value Representation (VR) – the format type of an individual DICOM data element, such as text, an integer, a person's name, or a code. DICOM information objects can be transmitted with either explicit identification of the type of each data element (Explicit VR), or without explicit identification (Implicit VR); with Implicit VR, the receiving application must use a DICOM data dictionary to look up the format of each data element.

1.5. BASICS OF DICOM COMMUNICATION

This section describes terminology used in this Conformance Statement for the non-specialist. The key terms used in the Conformance Statement are highlighted in italics below. This section is not a substitute for training about DICOM, and it makes many simplifications about the meanings of DICOM terms.

Two *Application Entities* (devices) that want to communicate with each other over a network using DICOM protocol must first agree on several things during an initial network "handshake". One of the two devices must initiate an *Association* (a connection to the other device), and ask if specific services, information, and encoding can be supported by the other device (Negotiation).

DICOM specifies a number of network services and types of information objects, each of which is called an *Abstract Syntax* for the Negotiation. DICOM also specifies a variety of methods for encoding data, denoted *Transfer Syntaxes*. The Negotiation allows the initiating Application Entity to propose combinations of Abstract Syntax and Transfer Syntax to be used on the Association; these combinations are called *Presentation Contexts*. The receiving Application Entity accepts the Presentation Contexts it supports.

For each Presentation Context, the Association Negotiation also allows the devices to agree on *Roles* – which one is the *Service Class User* (SCU - client) and which is the *Service Class Provider* (SCP - server). Normally the device initiating the connection is the SCU, i.e., the client system calls the server, but not always.

The Association Negotiation finally enables exchange of maximum network packet (*PDU*) size, security information, and network service options (called *Extended Negotiation* information).

The Application Entities, having negotiated the Association parameters, may now commence exchanging data. Common data exchanges include queries for worklists and lists of stored images, transfer of image objects and analyses (structured reports), and sending images to film printers. Each exchangeable unit of data is formatted by the sender in accordance with the appropriate *Information Object Definition*, and sent using the negotiated Transfer Syntax. There is a Default Transfer Syntax that all systems must accept, but it may not be the most efficient for some use cases. Each transfer is explicitly acknowledged by the receiver with a *Response Status* indicating success, failure, or that query or retrieve operations are still in process.

Two Application Entities may also communicate with each other by exchanging media (such as a CD-R). Since there is no Association Negotiation possible, they both use a *Media Application Profile* that specifies "pre-negotiated" exchange media format, Abstract Syntax, and Transfer Syntax.

1.6. ABBREVIATIONS

AE	Application Entity
AET	Application Entity Title
CD-R	Compact Disk Recordable
DICOM	Digital Imaging and Communications in Medicine
DX	Digital X-Ray
IOD	Information Object Definition
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISO	International Organization for Standards
IO	Intra-oral X-Ray
MTU	Maximum Transmission Unit (IP)
O	Optional (Key Attribute)
PACS	Picture Archiving and Communication System
PDU	Protocol Data Unit
R	Required (Key Attribute)
SCP	Service Class Provider
SCU	Service Class User
SOP	Service/Object Pair
TCP/IP	Transmission Control Protocol/Internet Protocol
U	Unique (Key Attribute)
VR	Value Representation

1.7. REFERENCES

NEMA PS3	Digital Imaging and Communications in Medicine (DICOM) Standard, NEMA, http://medical.nema.org/
PI IG	Progeny Imaging Install Guide, Midmark, document # 00-02-1604
PI UM	Progeny Imaging User's Manual, Midmark, document # 00-02-1598
PI VM	Progeny Imaging Vet User's Manual, Midmark, document # 00-02-1605

2. NETWORKING

2.1. IMPLEMENTATION MODEL

2.1.1. Application Data Flow

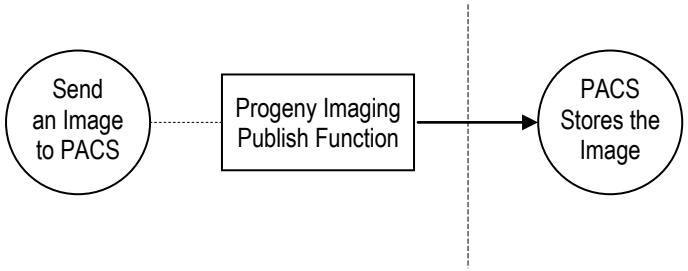

Figure 1: Data Flow Diagram

The local real-world activity "Send an Image to PACS" relate with Progeny Imaging's Publish Function to send an image to a remote AE. The result remote activity is that "PACS Stores the Image" in its internal image database. "Send an Image to PACS" local activity is performed upon user request for specific images selected when the functionality is activated by user's settings.

2.2. FUNCTIONAL OVERVIEW

2.2.1. Functional Definition of AE's

2.2.1.1. Functional Definition of Progeny Imaging's Publish Function

Progeny Imaging's Publish Function is enabled by specifying the Title, IP, and Port of the remote AE and by setting true in the "ViewPublish" attribute in PACS.xml file as specified in Progeny Imaging Install Guide (PI IG). An association request is sent to the destination AE every time when the user chooses to publish an image to the remote AE, and upon successful negotiation of a Presentation Context the image transfer is started. If the association cannot be opened, the related send-job is canceled and the user is notified. Progeny Imaging's Publish Function will not try to initiate another association for this send-job automatically and the user has to repeat the request manually.

2.2.2. Sequencing of Real World Activities

Progeny Imaging's Publish Function does not expect specific sequencing of the real world activities.

2.3. AE SPECIFICATIONS:

2.3.1. Progeny Imaging's Publish Function

2.3.1.1. SOP Classes

Progeny Imaging's Publish Function provides Standard Conformance to the SOP Classes listed in Table 2, page 10.

Table 2: SOP Classes for Progeny Imaging's Publish Function

SOP Class Name	SOP Class UID	SCU	SCP
Digital Intra-oral X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.3	Yes	No

2.3.1.2. Association Policies

2.3.1.2.1. General

The DICOM standard application context name for DICOM 3.0 is always proposed:

Table 3: DICOM Application Context for Progeny Imaging's Publish Function

Application Context Name	1.2.826.0.1.3680043.8.425

2.3.1.2.2. Number of Associations

Progeny Imaging's Publish Function establish one association for each image transferred sequentially. Only one association will be active at a time, the other remains pending until the current image is transferred or the operation fails.

Table 4: Number of Associations Initiated for Progeny Imaging's Publish Function

Maximum number of simultaneous Associations	1

2.3.1.2.3. Asynchronous Nature

Progeny Imaging's Publish Function does not support asynchronous communication (multiple outstanding transactions over a single Association).

Table 5: Asynchronous Nature as a SCU for Progeny Imaging's Publish Function

Maximum number of outstanding asynchronous transactions	1

2.3.1.2.4. Implementation Identifying Information

The implementation information for the Progeny Imaging's Publish Function is shown on Table 6, page 10.

Table 6: DICOM Implementation Class and Version for Progeny Imaging's Publish Function

Implementation Class UID	1.2.840.10008.5.1.4.1.1.1.3

2.3.1.3. Association Initiation Policy

2.3.1.3.1. Activity – Send an Image to PACS

2.3.1.3.1.1. Description and Sequencing of Activities

A user can select images and request them to be sent to the Storage SCU (PACS) previously described in the PACS.xml configuration file. Each request is executed individually.

The Progeny Imaging's Publish Function AE is invoked by the Progeny Imaging GUI. The internal implementation initiates a C-STORE request for each image separately. If the process successfully establishes an Association to a remote AE, it will transfer the current image via the open Association. Status of the transfer is reported through the Progeny Imaging GUI. Only one image will be transferred at a time. If the C-STORE Response from the remote Application contains a status other than Success or Warning, the Association is aborted and the related image transfer is stopped. It can be restarted any time manually by user interaction in Progeny Imaging GUI.

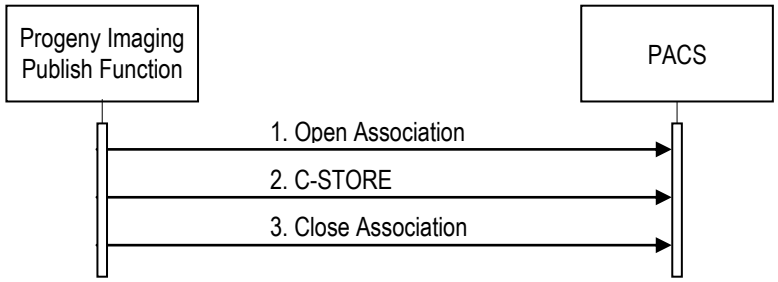

Figure 2: Sequencing of Activities – Send an Image to PACS

A possible sequence of interactions between the Progeny Imaging's Publish Function AE and a PACS (e.g. a storage or archive device supporting the Storage and Storage Commitment SOP Classes as an SCP) is illustrated in Figure 2, page 11:

1. Progeny Imaging's Publish Function AE opens an association with the PACS
2. The image is transmitted to the PACS using a C-STORE request and the PACS replies with a C-STORE response (status success).
3. The Progeny Imaging's Publish Function AE closes the association with the PACS.

2.3.1.3.1.2. Proposed Presentation Contexts

Progeny Imaging's Publish Function is capable of proposing the Presentation Contexts shown in Table 7, page 11.

Table 7: Proposed Presentation Contexts for Progeny Imaging's Publish Function

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Ext. Neg.**
Name	**UID**	**Name List**	**UID List**		
Digital Intra-oral X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.3	Explicit VR Little Endian	1.2.840.10008.1.2.1	SCU	None

2.3.1.3.1.3. SOP Specific Conformance for SOP Classes

All Image and Presentation State Storage SOP Classes supported by the Progeny Imaging's Publish Function AE exhibit the same behavior. The behavior of Progeny Imaging's Publish Function AE when encountering status codes in a C-STORE response is summarized in Table 8, page 12.

Table 8: C-STORE Response Status Handling Behavior for Progeny Imaging's Publish Function

Service Status	Further Meaning	Error Code	Behavior
Success	Success	0000	The SCP has successfully stored the SOP Instance. If all image transfers have status success then the user is notified for the successful Publish operation.
*	*	Any other status code	The Association is aborted using A-ABORT and the user is notified that the Publish operation is failed.

2.4. NETWORK INTERFACES

2.4.1. Physical Network Interface

The implementation relies on the host computer and the operating system for implementing the physical network interface. No additional physical network limitations are introduced.

2.4.2. Additional Protocols

The implementation relies on the host computer and the operating system for implementing of any additional protocols. No additional protocols are implemented.

2.4.3. IPv4 and IPv6 Support

Only supports IPv4 connections are supported.

2.5. CONFIGURATION

2.5.1. AE Title/Presentation Address Mapping

2.5.1.1. Local AE Titles.

Progeny Imaging's Publish Function AE has fixed AE Title and selects automatically the TCP/IP port for communication. No additional configuration is necessary.

Table 9: AE Title Configuration Table

Application Entity	Default AE Title	Default TCP/IP Port
Progeny Imaging's Publish Function	PROGENYIMAGING	2001

2.5.1.2. Remote AE Title/Presentation Address Mapping

Progeny Imaging's Publish Function AE has to be configured by specifying the Storage SCU (PACS) Title, IP, and Port and by setting true in the "ViewPublish" attribute in PACS.xml file as specified in Progeny Imaging Install Guide (PI IG).

2.5.2. Parameters

No configurable parameters are implemented. The default values are specified in Table 10, page 13.

Table 10: Configuration Parameters Table

Parameter	Configurable (Yes/No)	Default Value
General Parameters		
Max PDU Receive Size	No	16384
Max PDU Send Size	No	16384
Progeny Imaging's Publish Function Parameters		
Number of times a failed send image may be retried	No	0 (failed send images are not retried)
Maximum number of simultaneously initiated Associations	No	1
Supported Transfer Syntaxes	No	Implicit VR Little Endian

3. MEDIA INTERCHANGE

Progeny Imaging does not support Media Storage.

4. SUPPORT OF CHARACTER SETS

Supported are the following character sets:

- ISO_IR 100 (ISO 8859-1:1987 Latin Alphabet No. 1 supplementary set)

5. SECURITY

No security profiles are used in relation with the DICOM operation.

Progeny Imaging uses username and password authentication methods to identify the user controlling Progeny Imaging.

6. ANNEXES

6.1. IOD CONTENTS

6.1.1. Created SOP Instance(s)

Table 11, page 17 specifies the attributes of a Digital Intra-oral X-Ray Image – For Presentation transmitted by the Progeny Imaging's DICOM implementation.

Table 11: IOD of Created Digital Intra-oral X-Ray Image – For Presentation

IE	Module	Reference	Presence of Module
Patient	Patient	C.7.1.1	ALWAYS
Study	General Study	C.7.2.1	ALWAYS
Series	General Series	C.7.3.1	ALWAYS
Series	DX Series	C.8.11.1	ALWAYS
Series	Intra-Oral Series	C.8.11.8	ALWAYS
Equipment	General Equipment	C.7.5.1	ALWAYS
Image	General Image	C.7.6.1	ALWAYS
Image	Image Pixel	C.7.6.3	ALWAYS
Image	DX Anatomy Imaged	C.8.11.2	ALWAYS
Image	DX Image	C.8.11.3	ALWAYS
Image	DX Detector	C.8.11.4	ALWAYS
Image	Intra-Oral Image	C.8.11.9	ALWAYS
Image	Acquisition Context	C.7.6.14	ALWAYS
Image	SOP Common	C.12.1	ALWAYS

6.1.2. Usage of Attributes from received IOD's

Table 12: Usage of Attributes from received IOD's

IOD	Attribute Name	Tag	Attribute Description
Patient	Patient's Age	(0010,1010)	Age of the Patient
Patient	Patient's Birth Date	(0010,0030)	Date of birth of the named patient
Patient	Patient's Sex	(0010,0040)	Sex of the named patient; Enumerated Values: • M = male • F = female • O = other
Patient	Patient's Name	(0010,0010)	Patient's full name
Patient	Patient ID	(0010,0020)	Primary hospital identification number or code for the patient
Patient	Patient Comments	(0010,4000)	User-defined comments about the patient
Study	Study Instance UID	(0020,000D)	Unique identifier to be used to identify the Study
Study	Study ID	(0020,0010)	User or equipment generated Study Identifier

IOD	Attribute Name	Tag	Attribute Description
Study	Study Date	(0008,0020)	Date the Study started
Study	Study Time	(0008,0030)	Time the Study started
General	SOP Instance UID	(0008,1155)	Uniquely identifies the referenced SOP Instance.
Series	Series Instance UID	(0020,000E)	Unique identifier of the Series
Series	Series Number	(0020,0011)	A number that identifies this Series
Series	Series Date	(0008,0021)	Date the Series started
Series	Series Time	(0008,0031)	Time the Series started
Series	Related Series Sequence	(0008,1250)	Identification of Series significantly related to this Series. Zero or more Items may be present
Series	Performing Physicians' Name	(0008,1050)	Name of the physician(s) administering the Series
Equipment	Manufacturer	(0008,0070)	Manufacturer of the equipment to be used for beam delivery
Equipment	Manufacturer's Model Name	(0008,1090)	Manufacturer's model name of the equipment that produced the composite instances
Equipment	Institution Name	(0008,0080)	Institution where the equipment that produced the composite instances is located.
Image	Images in Acquisition	(0020,1002)	Number of images that resulted from this acquisition of data
Image	Acquisition Date	(0008,0022)	The date the acquisition of data that resulted in this image started
Image	Acquisition Time	(0008,0032)	The time the acquisition of data that resulted in this image started
Image	Software Versions	(0018,1020)	The current software version 1.6 is used.
Image	Burned In Annotation	(0028,0301)	Indicates whether or not image contains sufficient burned in annotation to identify the patient and date the image was acquired. Fixed enumerated value NO is used.
Image	Rescale Type	(0028,1054)	Specifies the output units of Rescale Slope (0028,1053) and Rescale Intercept (0028,1052). Fixed value US is used.
Image	Rescale Slope	(0028,1053)	Fixed value 1 is used.
Image	Presentation LUT Shape	(2050,0020)	Specifies an identity transformation for the Presentation LUT, such that the output of all grayscale transformations defined in the IOD containing this Module are defined to be P-Values. Fixed value IDENTITY is used.
Image	Window Center	(0028,1050)	Defines a Window Center for display
Image	Window Width	(0028,1051)	Window Width for display
Image	Imager Pixel Spacing	(0018,1164)	Physical distance measured at the front plane of the detector housing between the center of each image pixel specified by a numeric pair - row spacing value(delimiter) column spacing value in mm.

IOD	Attribute Name	Tag	Attribute Description
Image	Detector ID	(0018,700A)	The ID or serial number of the detector used to acquire this image
Image	Positioner Type	(0018,1508)	Defined Terms: • CARM • COLUMN • MAMMOGRAPHIC • PANORAMIC • CEPHALOSTAT • RIGID • NONE

6.1.3. Attribute Mapping

No attribute mapping is implemented.

6.1.4. Coerced/Modified Fields

No Attribute is coerced or modified.

6.2. DATA DICTIONARY OF PRIVATE ATTRBUTES

No private Attribute is implemented.

6.3. CODED TERMINOLOGY AND TEMPLATES

No Coded Terminology is supported.

6.4. GRAYSCALE IMAGE CONSISTENCY

No DICOM Grayscale Standard Display Function is supported.

6.5. STANDARD EXTENDED/SPECIALIZED/PRIVATE SOP CLASSES

No Specialized or Private SOP Classes are supported.

6.6. PRIVATE TRANSFER SYNTAXES

No Private Transfer Syntaxes are supported.

