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**QDR FOR WINDOWS XP 12.4  
DICOM CONFORMANCE STATEMENT**

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## 1. Introduction

### 1.1. Purpose of the Document

This document is the DICOM Conformance Statement for Hologic QDR Bone Densitometers, version 12.4. It describes DICOM capabilities of the QDR and how it conforms to the DICOM 3.0 standard.

### 1.2. References

1. American College of Radiology - National Electrical Manufacturers Association (ACR-NEMA) Digital Imaging and Communications in Medicine V3.0-2000.

### 1.3. Definitions

This section provides the definitions of terms, acronyms, and abbreviations that are used throughout the document.

DICOM	Digital Imaging and Communication in Medicine, a standard on image communications in medical applications
HIS	Hospital Information System
RIS	Radiology Information System
AE	Application Entity
SCU	Service Class User
SCP	Service Class Provider
SOP	Service-Object Pair, a definition of an information object (like an image) and of service (like storage) that can be performed for the object
VR	Value Representation, a data encoding method in DICOM
UID	Unique Identifier
DIMSE	DICOM Message Service Element
TCP/IP	Transmission Control Protocol / Internet Protocol, a widely used computer networking protocol
MWL	Modality Worklist
MPPS	Modality Performed Procedure Step

## 2. Implementation Model

### 2.1. Application Data Flow Diagram

There are four Real-World Activities that occur in the QDR: Storage, Storage Commitment, Modality Worklist, and Modality Performed Procedure Step. The Application Data Flow Diagram shown on Figure 1 represents all of the Application Entities present in the QDR application, and graphically depicts the relationship of the AE's use of DICOM to Real-World Activities.

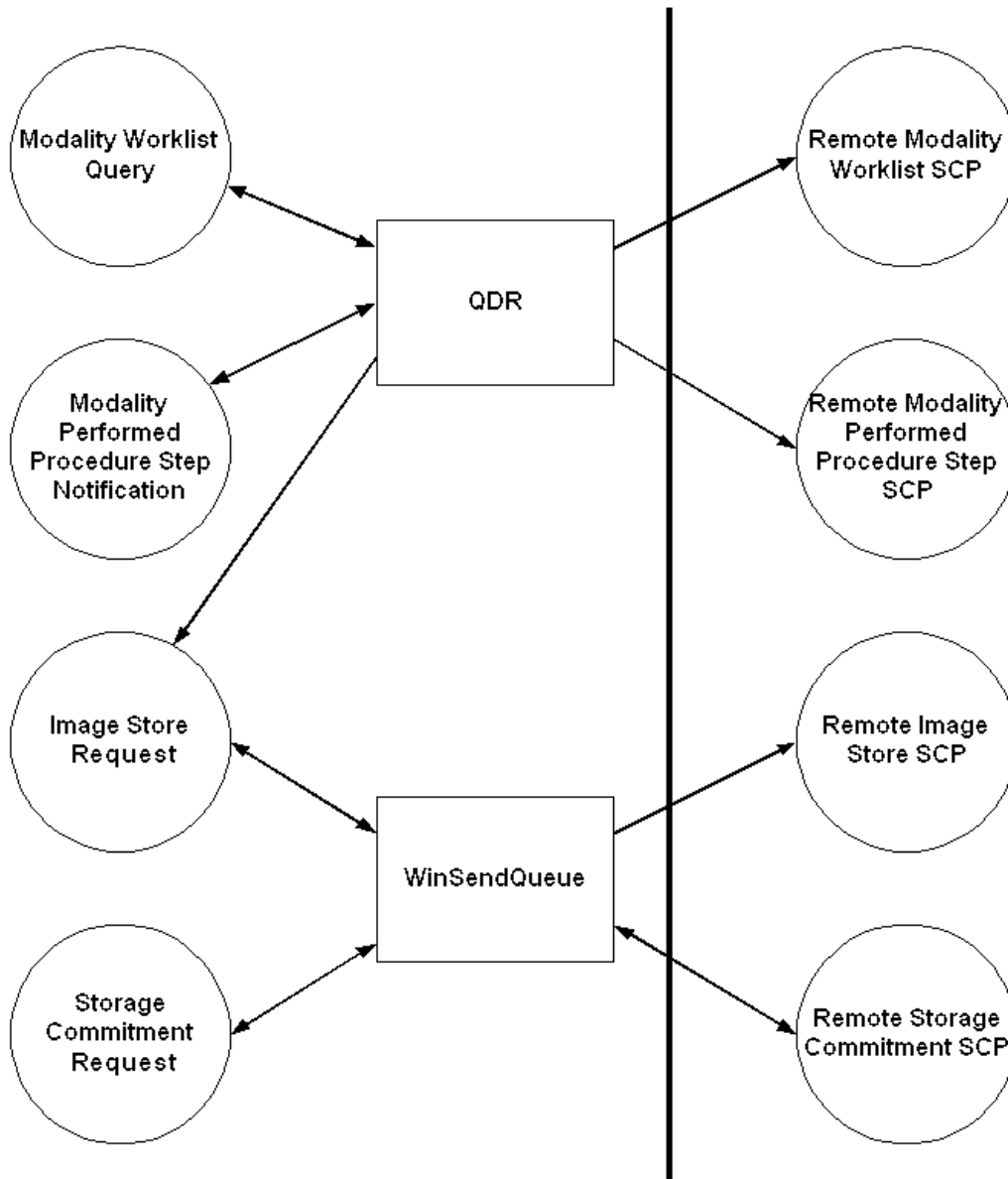


Figure 1. Application Data Flow Diagram.

### 2.1.1. Storage

1. QDR application generates DICOM files and stores them locally.
2. WinSendQueue application initiates an association with remote Storage SCP.
3. WinSendQueue application pushes files to the remote Storage SCP using C-STORE command, and then closes the association.

### 2.1.2.Storage Commitment

1. WinSendQueue application initiates an association with remote Storage Commitment SCP.
2. WinSendQueue application sends a Storage Commitment request to the remote Storage Commitment SCP using N-ACTION command, and then closes the association.
3. The remote Storage Commitment SCP initiates an association with WinSendQueue application and uses N-EVENT-REPORT command to send a notification about Storage Commitment results, and then closes the association.

### 2.1.3.Modality Worklist

1. QDR application initiates an association with remote Modality Worklist SCP.
2. QDR application queries the Modality Worklist SCP to obtain Modality Worklist information using C-FIND command, and then closes the association.
3. QDR application stores obtained Modality Worklist information in the local database.

### 2.1.4. Modality Performed Procedure Step

1. QDR application initiates an association with remote Modality Performed Procedure Step SCP.
2. QDR application notifies the MPPS SCP about started procedure using N-CREATE command, and then closes the association.
3. QDR application initiates an association with remote MPPS SCP.
4. QDR application notifies the MPPS SCP about completed or canceled procedure using N-SET command, and then closes the association.

### **2.2. Functional Definitions of AE's**

There are two software applications: QDR and WinSendQueue representing two Application Entities.

#### **2.2.1. QDR**

The QDR application may serve as an SCU for Modality Worklist and Modality Performed Procedure Step services.

According to the configuration settings (Section 5), the QDR application initiates an association with the Modality Worklist SCP and queries it for Modality Worklist information using C-FIND Request. Upon receipt of a successful C-FIND Response Status Code from the SCP, the QDR application closes the association and stores received Worklist information into a local database for future use.

In case of error (either network error, or problems experienced by the SCP, or receiving a failure Status Code with C-FIND Response), the QDR application closes the association (if it is still open), and will retry the entire Worklist Service flow according to the configuration settings.

If the MPPS Service is enabled (Section 5), the QDR application sends MPPS notification messages to the MPPS SCP.

Right after the QDR scanning process starts, the QDR application initiates an association with the MPPS SCP and notifies it about a started procedure using N-CREATE Request. Upon receipt of a successful N-CREATE Response Status Code, the QDR application closes the association and is ready for sending a notification about procedure completion. In case of error, it will retry the entire flow according to configuration settings.

Right after the QDR scanning process is either completed or aborted, and if the previous N-CREATE Request was successful, the QDR applications initiates an association with the MPPS SCP and notifies it about procedure status using N-SET Request. Upon receipt of a successful N-SET Response Status Code, the QDR application closes the association with the MPPS SCP. In case of error, it will retry the entire flow according to configuration settings.

#### **2.2.2. WinSendQueue**

The WinSendQueue application may serve as an SCU for Storage and Storage Commitment services.

After the QDR application generates DICOM files and stores them locally, the WinSendQueue application may send them to one or more remote Storage SCP. It

initiates an association, and sends files using C-STORE Request. Upon receipt of a C-STORE Response Code Status or in case of error, it closes the association. In case of error, the WinSendQueue application will retry the entire flow according to configuration settings.

One of the remote Storage SCPs may also serve as a Storage Commitment SCP. After successful completion of Storage Service, the WinSendQueue application will send an N-ACTION request for Storage Commitment to such SCP. Upon receipt of an N-ACTION Response, it closes the association. If the Response status is successful, the WinSendQueue application starts waiting for the notification message from the Storage Commitment SCP, otherwise the Storage Commitment operation is considered Failed. Upon receiving a notification message from the Storage Commitment SCP (the N-EVENT-REPORT Request), the WinSendQueue application sends back an N-EVENT-REPORT Response. The notification message from the SCP lists both: files successfully stored and files that it failed to store. The SCP closes the association.

### **2.3. Sequencing of Real-World Activities**

1. A Storage Commitment Request for a specific study and SCP may be sent only after successful completion of a Storage Request for the same study and SCP.
2. MPPS notifications for a specific procedure will be sent only if the procedure was previously retrieved using Modality Worklist service (i.e. not entered manually).

## **3. AE Specifications**

### **3.1. QDR – Specification**

QDR application provides Standard Conformance to the following DICOM V3.0 SOP Classes as an SCU:

SOP Class Name	SOP Class UID
Modality Worklist Information Model - FIND	1.2.840.10008.5.1.4.31
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3

### 3.1.1. Association Establishment Policies

#### 3.1.1.1. General

The maximum PDU length is 28,672 bytes.  
The SOP Class Extended Negotiation is not supported.

#### 3.1.1.2. Number Of Associations

QDR application initiates only one association at a time.

#### 3.1.1.3. Asynchronous Nature

QDR application does not support asynchronous communications.

#### 3.1.1.4. Implementation Identifying Information

The Implementation Identifying Information for QDR is:

Implementation Class UID	1.2.840.113850.1
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### 3.1.2. Association Initiation by Real-World Activity

QDR application initiates a new association for two Real-World Activities:

1. Modality Worklist request.
2. Modality Performed Procedure Step notification.

#### 3.1.2.1. Modality Worklist

##### 3.1.2.1.1. *Associated Real-World Activity*

The Modality Worklist service may start in three ways:

- Upon the User's request
- According to the scheduled time
- As a retry after the previous one has failed

In either case the QDR application initiates an association with the Modality Worklist SCP. Once the association has been established, the QDR sends a Worklist query

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according to user-configured parameters and waits for transmission of conformant Modality Worklist Service messages. The association is closed after retrieving the last message or after an error.

### *3.1.2.1.2. Proposed Presentation Contexts*

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Modality Worklist Find	1.2.840.10008.5.1.4.31	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

### *3.1.2.1.3. SOP Specific Conformance*

#### **3.1.2.1.3.1. Modality Worklist Matching Keys**

The following attributes are user-configurable and may be used in Modality Worklist query:

Matching Key Attribute	Tag
Scheduled Procedure Step Start Date	0040, 0002
Modality	0008, 0060
Scheduled Station AE Title	0040, 0001

#### **3.1.2.1.3.2. Modality Worklist Return Keys**

The QDR application supports all attributes defined by a Worklist Information Model as Return Key Attributes, no matter what Data Element Type they have. The list of attributes

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is configurable, so specific attributes may be removed if it is required. By default, QDR is configured to use all attributes.

### 3.1.2.1.3.3. Modality Worklist Message Status Codes

The following table describes QDR behavior depending on Status Codes of messages received from the Worklist SCP.

Status	Status Code	Meaning	QDR Behavior
Success	0000	Matching is complete – No final Identifier is supplied	Completes retrieving of matches
Pending	FF00	Matches are continuing – Current Match is supplied and any Optional Keys were supported in the same manner as Required Keys	Receiving of matches continues
Pending (No Optional Key Support)	FF01	Matches are continuing – Warning that one or more Optional Keys were not supported for existence for this Identifier	Receiving of matches continues without any warnings or errors
Other	Other	All other Status Codes	Terminates receiving of matches and logs a failure message. The matches received prior to this code are handled normally.

### 3.1.2.1.3.4. Error Handling

If an error occurs while processing a Worklist response message (for example, if a required attribute has invalid value), this message is skipped and the QDR proceeds with next messages.

## 3.1.2.2. Modality Performed Procedure Step

### 3.1.2.2.1. Associated Real-World Activity

The QDR application initiates an association with the Modality Performed Procedure Step SCP in two cases:

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- Right after a QDR scan procedure started, with status “IN PROGRESS”
- Right after a QDR scan procedure either completed (with status “COMPLETED”), or aborted (with status “DISCONTINUED”).

### 3.1.2.2.2. Proposed Presentation Contexts

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Modality Worklist Find	1.2.840.10008.5.1.4.31	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

### 3.1.2.2.3. SOP Specific Conformance

#### 3.1.2.2.3.1. N-CREATE Request

The QDR application supports following attributes used in Modality Performed Procedure Step N-CREATE Request:

Module Name	Supported Attributes
Performed Procedure Step Relationship	All attributes
Performed Procedure Step Information	All Type 1 attributes
Image Acquisition Results	All Type 1 attributes
Radiation Dose	Not supported
Billing and Material Code	Not supported

In order to conform to DICOM requirements for Type 2 attributes, all non-supported attributes of Type 2 are included in N-CREATE message with empty values.

The QDR application expects to get back an N-CREATE response with an attribute (0000,1000) (Affected SOP Instance UID) filled out with a Unique ID identifying this transaction.

**3.1.2.2.3.2. N-SET Request**

The QDR application supports following attributes used in MPPS N-SET Request:

Attribute Name	Attribute Tag
Performed Procedure Step Status	0040,0252

The QDR fills attribute (0000,1001) (Requested SOP Instance UID) with a transaction Unique ID received with N-CREATE response message.

**3.1.3. Association Acceptance Policy**

No associations will be accepted by the QDR application.

**3.2. WinSendQueue – Specification**

WinSendQueue application provides Standard Conformance to the following DICOM V3.0 SOP Classes as an SCU:

SOP Class Name	SOP Class UID
Secondary Capture Storage	1.2.840.10008.5.1.4.1.1.7
Storage Commitment Push Model	1.2.840.10008.1.20.1

**3.2.1. Association Establishment Policies**

**3.2.1.1. General**

The maximum PDU length for a Storage Service is 16,384 bytes.  
The maximum PDU length for a Storage Commitment Service is 28,672 bytes.  
The SOP Class Extended Negotiation is not supported.

**3.2.1.2. Number of Associations**

WinSendQueue application initiates only one association at a time.

### 3.2.1.3. Asynchronous Nature

WinSendQueue application does not support asynchronous communications.

### 3.2.1.4. Implementation Identifying Information

The Implementation Identifying Information for WinSendQueue application is:

Implementation Class UID	1.2.840.113850.1
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### 3.2.2. Association Initiation by Real-World Activity

WinSendQueue application initiates a new association for two Real-World Activities:

1. Storage request.
2. Storage Commitment request.

#### 3.2.2.1. Storage

##### *3.2.2.1.1. Associated real-World Activity*

WinSendQueue application initiates an association with Storage SCP and sends DICOM files using C-STORE command.

##### *3.2.2.1.2. Proposed Presentation Contexts*

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Secondary Capture Storage	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

##### *3.2.2.1.3. SOP Specific Conformance*

Module	Attribute Name	Type	Value	Tag	VR
Patient	Patient's Name	2		0010, 0010	PN
	Patient ID	2		0010, 0020	LO

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	Patient's Birth Date	2		0010, 0030	DA
	Patient's Sex	2		0010, 0040	CS
General Study	Study Instance UID	1	Note 11	0020, 000D	UI
	Study Date	2		0008, 0020	DA
	Study Time	2		0008, 0030	TM
	Referring Physician's Name	2		0008, 0090	PN
	Study ID	2	Note 1	0020, 0010	SH
	Accession Number	2	Note 1	0008, 0050	SH
	Study Description	3		0008, 1030	LO
	Physician Reading Study	3	Note 17	0008, 1060	PN
General Series	Modality	1	"OT"	0008, 0060	CS
	Series Instance UID	1	Note 11	0020, 000E	UI
	Series Number	2	Note 14	0020, 0011	IS
	Laterality	2C	Note 5	0020, 0060	CS
	Body Part Examined	3	Note 4	0018, 0015	CS
General Equip.	Manufacturer	2	"Hologic"	0008, 0070	LO
	Institution Name	3	Note 18	0008, 0080	LO
	Station Name	3	Note 9	0008, 1010	SH
	Manfr's Model Name	3	Note 7	0008, 1090	LO
	Device S/N	3	Note 7	0018, 1000	LO
	S/W Versions	3	Note 7	0018, 1020	LO
SC Equipment	Conversion Type	1	"WSD"	0008, 0064	CS
	SC Device Software Version	3	Note 8	0018, 1019	LO
General Image	Image Number	2	"1"	0020, 0013	IS
	Patient Orientation	2C	Note 6	0020, 0020	CS
	Image Comments	3	Note 2	0020, 4000	LT
Image Pixel	Samples per pixel	1	"1"	0028, 0002	US
	Photometric Interpretation	1	Note 10	0028, 0004	CS
	Rows	1		0028, 0010	US
	Columns	1		0028, 0011	US
	Bits Allocated	1	Note 13	0028, 0100	US
	Bits Stored	1	Note 13	0028, 0101	US
	High Bit	1	Note 13	0028, 0102	US
	Pixel Representation	1	"0000H"	0028, 0103	US
	Pixel Data	1		7FE0, 0010	OB
	Pixel Aspect Ratio	1C	"1\1"	0028, 0034	IS
SC Image	Date of Secondary Capture	3	Note 3	0018, 1012	DA

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	Time of Secondary Capture	3	Note 3	0018, 1014	TM
Other	Window Center	3	Note 13	0028, 1050	DS
	Window Width	3	Note 13	0028, 1051	DS
SOP Common	SOP Class UID	1	Note 12	0008, 0016	UI
	SOP Instance UID	1	Note 11	0008, 0018	UI
Hx Questionnaire	Private Creator Data Element	1C	Note 15	0011, 0010	LO
	HxQuestionnaire	3	Note 16	0011, 1000	OB

Notes:

1. Accession number entered by operator is placed in both fields.
2. Text incorporating analysis results.
3. Date and time of this DICOM file creation.
4. Body Part Values: LSPINE, HIP, ARM. For scan types not described by these values, place NULL in the field.
5. Required only for paired structures. Values are: R = right, L = left.
6. Patient Orientation Values A, P, R, L, H, F.
7. These fields refer to the scan device.
8. These fields refer to the analyze device and software.
9. Station name is stored in a configuration table.
10. "MONOCHROME2"
11. All UIDs start with the following <org root>: 1.2.840.113850 (113850 represents a Hologic identifier assigned by ANSI).

The Study Instance UID consists of the <org root> followed by the unique part. The unique part is constructed as following: First, the structure nnnnn.sssss is created, where nnnnn is the Hologic serial number of the scanner, and sssss is the accession number if available. Then this structure is used as an input for MD5 hash algorithm function.

The Series Instance UID consists of the <org root> followed by the unique part. The unique part is constructed as following: First, the structure nnnnn.sssss.mm.ff is created, where nnnnn is the Hologic serial number of the scanner, sssss is the accession number if

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available, mm is the series number, and ff is the destination number. Then this structure is used as an input for MD5 hash algorithm function.

The SOP Instance UID consists of the <org root> followed by the unique part. The unique part is constructed as following: First, the structure nnnnn.sssss.mm.aaaa.ff is created, where nnnnn is the Hologic serial number of the scanner, sssss is the accession number if available, mm is the series number, aaaa is the analysis date and time, and ff is the destination number. Then this structure is used as an input for MD5 hash algorithm function.

12. SOP Class UID for Secondary Capture Image Storage Service Class is  
1.2.840.10008.5.1.4.1.1.7

13. Images can be either 8 or 12 bits deep. Values for each are:

	<u>8 bit</u>	<u>12 bit</u>
Bits Allocated	8	16
Bits Stored	8	12
High Bit	7	11
Window Center	128	2048
Window Width	256	4096

Single energy IVA images are 12 bits, all other images are 8 bits.

14. Series number starts at 1 and increases by 1 for each series in a study.

15. Required if HxQuestionnaire data element 0011, 1000 is present.

16. HxQuestionnaire data in binary format.

17. This field refers to the “Interpreting physician” field stored in the DICOM configuration nodes.

18. This fields refers to the “Institution Name” field stored in the Header Block of the Common Block Configuration table of the report settings.

### **3.2.2.2. Storage Commitment**

#### ***3.2.2.2.1. Associated Real-World Activity***

WinSendQueue application initiates an association with Storage Commitment SCP and sends a Storage Commitment request using N-ACTION command.

**3.2.2.2.2. Proposed Presentation Contexts**

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Storage Commitment Push Model	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

**3.2.2.2.3. SOP Specific Conformance**

The following attributes are used for Storage Commitment Request:

Attribute Name	Attribute Tag
Transaction UID	0008,1195
Retrieve AE Title	0008,0054
Referenced SOP Sequence	0008,1199
>Referenced SOP Class UID	0008,1150
>Referenced SOP Instance UID	0008,1155

**3.2.3. Association Acceptance Policy**

WinSendQueue application accepts an association only when it is received from Storage Commitment SCP to get a notification message about commitment status.

**3.2.3.1. Storage Commitment**

**3.2.3.1.1. Associated Real-World Activity**

Upon receipt of a successful N-ACTION response from the Storage Commitment SCP, the WinSendQueue application waits for a N-EVENT-REPORT request message from

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the SCP. Upon receiving such request, it accepts the association and sends back a N-EVENT-REPORT response message.

### *3.2.3.1.2. Proposed Presentation Contexts*

Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name List	UID List		
Storage Commitment Push Model	1.2.840.10008.1.20.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

### *3.2.3.1.3. SOP Specific Conformance*

The WinSendQueue application supports following attributes used in N-EVENT-REPORT message:

Attribute Name	Attribute Tag
Transaction UID	0008,1195
Retrieve AE Title	0008,0054
Referenced SOP Sequence	0008, 1199
>Referenced SOP Class UID	0008,1150
>Referenced SOP Instance UID	0008,1155
Failed SOP Sequence	0008,1198
>Referenced SOP Class UID	0008,1150
>Referenced SOP Instance UID	0008,1155

## **4. Communication Profiles**

### **4.1. Supported Communication Stacks**

DICOM Upper Layer (PS 3.8.) is supported using TCP/IP.

### **4.2. TCP/IP Stack**

The TCP/IP stack is inherited from the operating system on which it is running.

#### **4.2.1. Physical Media Support**

The physical medium is inherited from the computer on which it is running.

## **5. Configuration**

### **5.1. AE Title / Presentation Address Mapping**

The AE Title is configurable and normally is set up by Hologic service engineer during installation process. It can be configured by the user thereafter if it is required.

### **5.2. Configurable Parameters**

#### **5.2.1. Modality Worklist Service**

##### **5.2.1.1. User Configurable Parameters**

1. Worklist Query Parameters:
  - Scheduled Station AE Title
  - Modality
  - Days Back
  - Days Forward
  - Maximum Hits Per Query

2. Worklist SCP:
  - Remote AE Title
  - Remote Host
  - Remote Port Number
3. Automatic Worklist Query Interval
4. Worklist Query Retry Parameters:
  - Query Timeout
  - Retry Number
  - Retry Interval
5. Attribute Mapping. There are 15 QDR data fields that can be mapped to selected DICOM attributes:
  - Patient Name
  - Patient ID
  - Patient ID2
  - Patient Ethnicity
  - Patient DOB
  - Patient Sex
  - Patient Weight
  - Patient Height
  - Referring Physician
  - Procedure ID
  - Study Name
  - Procedure Start Date
  - HL7 Field 1
  - HL7 Field 2
  - HL7 Field 3

### **5.2.1.2. Service Engineer Configurable Parameters**

1. Attributes used as Worklist Query Return Keys.
2. Attributes available for Attribute Mapping for a specific QDR data field.

### **5.2.2. Modality Performed Procedure Step Service**

The user may select whether to use the Modality Performed Procedure Step Service or not.

### **5.2.3. Storage Service**

The following parameters may be configured by the user:

#### **5.2.3.1. Communication Parameters**

- Local AE Title
- Remote AE Title
- Remote Host
- Remote Port Number

#### **5.2.3.2. DICOM Attributes**

- Institution Name
- Station Name
- Physician Reading Study

### **5.2.4. Storage Commitment Service**

The user may select one of the existing Storage SCPs to serve also as a Storage Commitment SCP.

## **6. Support of Extended Character Set**

No Extended Character sets are supported.