

DICOM Conformance Statement

Product Name: ACUSON Sequoia
Ultrasound System

Release: 7.0

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1. Purpose

This document describes the conformance to the ACR_NEMA DICOM 3.0 Standard by the Acuson Sequoia™ ultrasound system release 7.0 from Siemens Medical Solutions, Ultrasound Division. It shall establish the conformance specifications for this system only, and does not apply to other products offered by Siemens Medical Solutions.

The Sequoia system is a device that generates ultrasound images and other data that can be set using DICOM standard protocols and definitions to other DICOM compliant devices including any DICOM compliant devices that support SOP classes as defined in Figure 2.1-2 in this document.

1.1 Scope

The DICOM standard provides a well-defined set of structures and protocols that allow inter-operability of a wide variety of medical imaging devices.

When configured with the DICOM option, the Sequoia system provides support for essential services related to ultrasound scanning and connectivity to DICOM compliant devices. The Sequoia system will not support all features supported by the DICOM standard. This document clearly states the DICOM services and data classes that are supported by the applications included with the Sequoia system. The intent of this document is to allow users and other vendors who also conform to the DICOM standard to exchange information within the specific context of those elements of the DICOM standard that the Sequoia system supports.

This document is written with respect to the adopted portions of the DICOM standard, Revision 3.0. The following sections of this document follow the outline specified in the DICOM Standard NEMA publication PS3.2.¹

2. Implementation Model

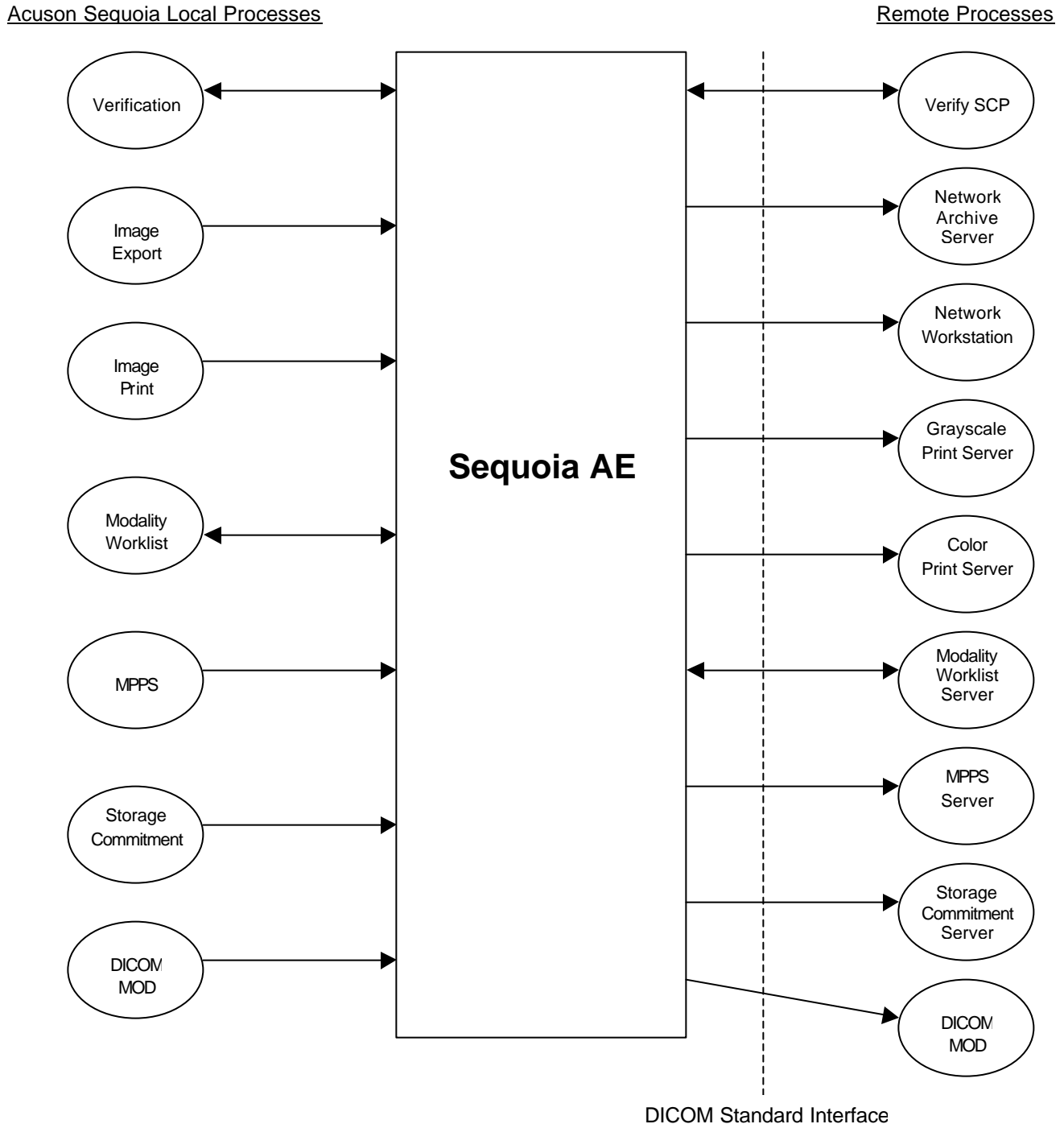
Sequoia system users can store images and other data directly on the Sequoia system hard disk. Images can be exported to a DICOM archive server or workstation on a network, and in addition to MO disk media. Storage Commitment is provide as “push model” only. The user is capable of querying a DICOM Worklist server for a list of scheduled patient procedures, as well as supporting a Modality Performed Procedure Step (MPPS) server. Printing of images to DICOM capable printers are also supported. In the following sections, the Sequoia system real world activities are indicated by “Real World Activity” name while “SEQUOIA AE” indicates the invoked Application Entity. Similarly, the activities associated with service providers are indicated as “Real World Service Activity”.

¹ Second part of the DICOM standard: NEMA Standards Publication PS 3.2-1998, Digital Imaging and Communications in Medicine (DICOM), Part 2: Conformance

2.1 Application Data Flow Diagram

Figure 2.1-1 illustrates the Implementation Model of the Sequoia system. The Sequoia system's Application Entity (AE) is shown in the box. Relationships between the user invoked activities (in the circles at the left of the AE) and the associated real-world activities provided by DICOM service providers (in the circles on the right side of the diagram) are shown.

Figure 2.1-1 Implementation Model



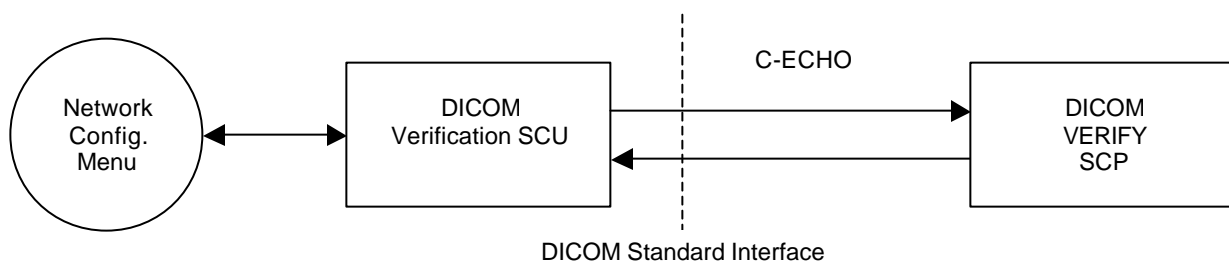
2.1.1 Verification

Verification is a part of the “Service UI – Network Setup” menu located in the Sequoia System Setup Menu. Verification can be used to send a DICOM verification request (Echo) to a remote Application Entity (AE) and will listen for a response. Verification on Sequoia can be done as an SCU or an SCP.

When Verification is used, the following messages are returned to the user:

1. Dicom echo successful (Successful)
2. DICOM: Failure during transport connection (Unsuccessful)

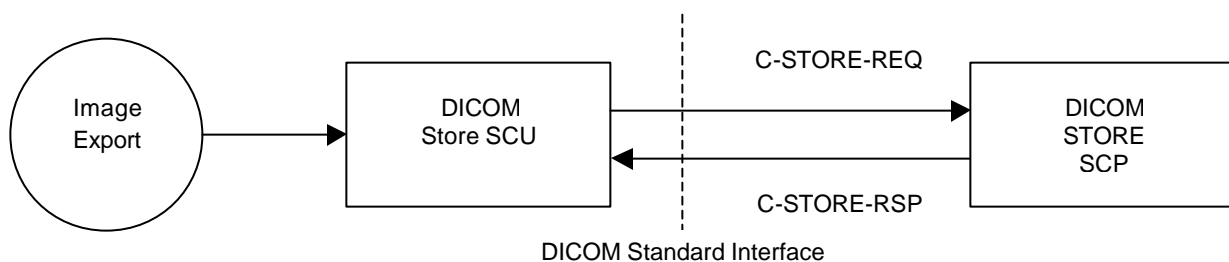
Figure 2.1.1-1 Verification Model



2.1.2 Image Export

Image Export allows the user to export Sequoia single frame and multi-frame ultrasound images to a DICOM archive server, which supports the Storage service class as an SCP. In addition, Sequoia also exports a Structured Report (SR) object to the DICOM archive server if the server supports this object.

Figure 2.1.2-1 Image Export Model



The user can manually use the Study Utils UI to select completed studies and export them on a single association. The destination is selected from a pop-up selection of pre-configured devices.

Additionally, there are automated background image export methods available using multiple associations. The system can be set to store either “in-progress” or “on study close” where:

- The system automatically exports an image as soon as it is captured and saved to the local disk while the study is currently open and in-progress.
- The system automatically exports all the images belonging to the current study as it closes.
- The system automatically exports one or more studies in the background, acquired while in a portable non-networked mode, once it is powered up on the network.

The “in-progress” method distributes the network load over time and can provide image review at the review station in near real-time (provided the server supports this capability). The “on study close” method lets the user store studies more accurately in the server. It is a common practice in Ultrasound to delete some images or modify demographic data before the study is closed.

In the event Sequoia is taken off the network as a portable system or when a network failure occurs during a background export, the Store SCU maintains a queue of failed C-STORE requests. These are periodically retried subsequent to the end of the study. The queue is also retried upon power cycling the Sequoia.

To use background export, the user pre-configures the destinations and mode of copy with the “Define Servers” setup under the Aegis menu located in the Sequoia System Setup. Images can be copied to two destinations.

2.1.2.1.1. Structured Reporting

If the DICOM archive server accepts the Sequoia proposed SR object in the Association Negotiation, the Structured Report object is exported with the Study Instance UID. Additionally, Sequoia will include the Structured Reporting SOP instance UID in the Storage Commitment N-ACTION request.

The Sequoia system uses a Private Structured Report (SR) SOP class as an SCU. It always creates a Structured Reporting object with each study and will automatically export the SR object in a C-STORE if successfully negotiated. The SR Presentation cannot be disabled through a configuration interface on Sequoia.

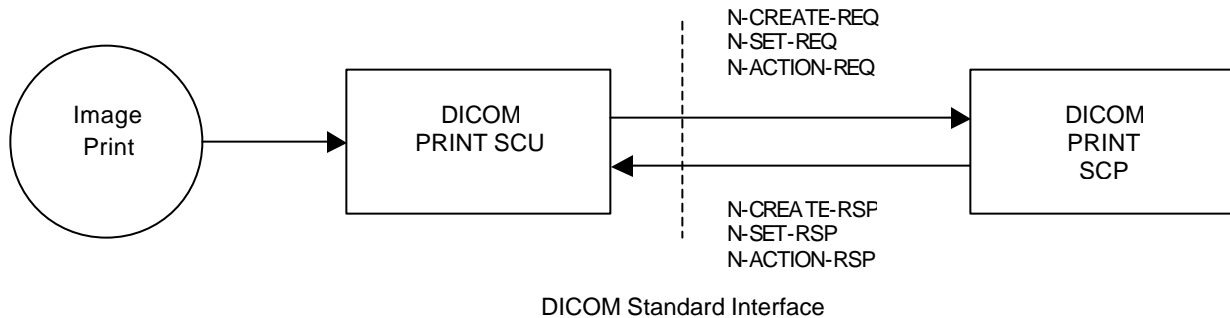
The SR object contains patient information and any measurements or calculations entered into one of the three Sequoia calculations package worksheets for OB, Cardiac, or Vascular studies.

The Acuson product implementation of Structured Reporting predated the adoption of DICOM Supplement 23 and substantially differs from that final version. Data contained in the Sequoia SR object cannot be extracted to populate other Structured Reporting implementations in non-Acuson devices. Acuson products use a Private Structured Reporting SOP Class UID 1.2.840.10008.5.1.4.1.1.88.3.

2.1.3 Image Print

Image Print allows the user to print Sequoia single frame Ultrasound images to a network DICOM printer.

Figure 2.1.3-1 Image Print Model



The user can manually use the Study Utils UI to select completed studies for printing. The printers and print formats are determined by the selections made in the “Define Printers” setup under the Aegis menu located in the Sequoia System Setup. It is possible to select one B&W and one color printer to route gray scale images and color Doppler images to separate printers.

Additionally, there are automated background printing methods available. The system can be setup to either print a study “in-progress” or “on study close” where:

- The system automatically prints a sheet of film as soon as enough static images have been captured to create a full format while the study is in-progress.
- The system automatically prints all films belonging to the study as soon as the study is closed.
- The system automatically prints in the background, acquired while in a portable non-networked mode, once it is powered up on the network.

Since it can take 30 seconds to several minutes to print all films, the “in-progress” setting will print most of the films before the study is closed. However, for ultrasound users who delete images throughout the study, the “on study close” method will give more correct study printouts.

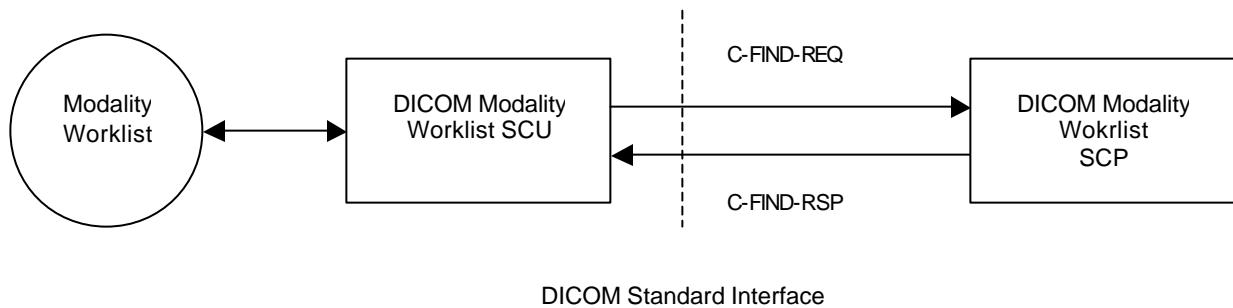
The user can use the “Print Now” button to force a partially formatted film before it is fully populated with images and automatic printing occurs.

In the event Sequoia is taken off the network as a portable system or a network failure is encountered during a background export, the Print SCU maintains a queue of failed print requests. These are periodically retried subsequent to the end of the study. The queue is also retried upon power cycling the Sequoia.

2.1.4 Modality Worklist

The Patient Demographics screen (the Begin Screen) can be automatically filled by using the 'Worklist' Real World Activity.

Figure 2.1.4-1 Modality Worklist Model



Depressing the 'Begin/End' key on the keyboard initiates the patient demographics screen. Clicking on the 'Query' button initiates the search. The search criteria is limited to the following Request to Return Elements:

- Patient Name
- Patient ID
- Accession Number
- Procedure Start Date
- Modality
- Station AE Title

Patient name fields that are partially filled or empty will be treated as though an implicit wildcard was appended at the end of the field. Patient ID and Accession Number will be exact match only. If only one matching patient is found in the query, the patient demographics screen will be immediately populated using the returned information. If no matches are found, a message will be presented to the operator indicating so. If more than one matching patient is found, a pick list of patient exams will be presented to the user to select from. The list will be limited to the number that is specified in the Dicom Worklist Server Setup.

The user will have the option to select a patient exam, or cancel the operation. Selection of a patient from the list will cause all demographic information for that patient to be loaded in the patient demographic screen.

The following data fields will be populated on the patient demographics screen:

| Attribute Name | Tag |
|---------------------|-------------|
| Patient's Full Name | (0010,0010) |
| Patient ID | (0010,0020) |

| | |
|----------------------|--------------|
| Study Type | (0040,0007)* |
| Accession Number | (0008,0050) |
| SSN | (0010,1000) |
| Date of Birth | (0010,0030) |
| Indication | (0040,1002) |
| Sex | (0010,0040) |
| Weight | (0010,1030) |
| Height | (0010,1020) |
| Diagnosing Physician | (0008,1060) |
| Referring Physician | (0008,0090) |

* This tag will later be mapped to the Study Description tag (0008,1030) in the Storage SOP Class.

See Section 3.1.2.4.2 (Modality Worklist Service SOP Class) for more specific details.

2.1.5 Modality Performed Procedure Step

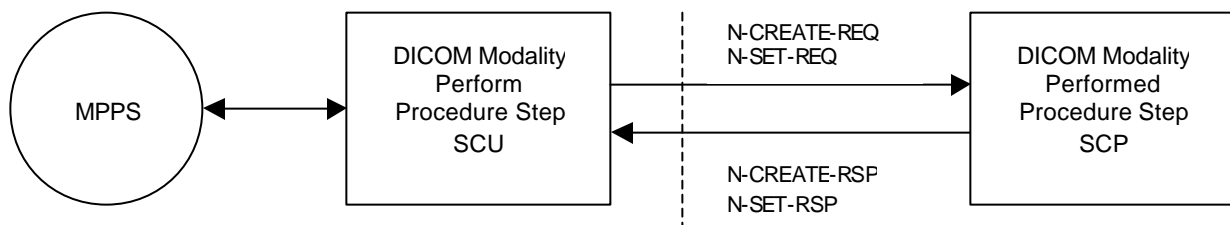
The Sequoia DICOM Modality Performed Procedure Step (MPPS) uses the DICOM 3.0 MPPS service class SCU to send event transactions for the start of a study (i.e. the first image is captured) and for the end of a study. The MPPS SCU is embedded in the Sequoia Begin (or patient demographic) page application and supports the N-Create and N-Set DIMSE Service Elements. A different MPPS server can be configured separately from a Modality Worklist server on the Sequoia system.

This information can be used by the Hospital Information System to manage its list of scheduled patients that is requested by a DICOM Modality Worklist query.

When a study is started on Sequoia, it uses the N-Create DIMSE to construct an MPPS-SOP with the MPPS server SCP. There is no further interaction with the MPPS SCP until the study ends. When the study is closed, the Sequoia system uses the N-Set DIMSE to set the values contained in the MPPS-SOP.

The Sequoia N-Set value for the “Performed Procedure Step Status” (0004,0252) is set to either “COMPLETED” or “DISCONTINUED”. Additionally, the contents of the “Performed Series Sequence” (0040,0340) are updated so that all mandatory attributes are supplied to the SCP.

Figure 2.1.5-1 Modality Performed Procedure Step Model



DICOM Standard Interface

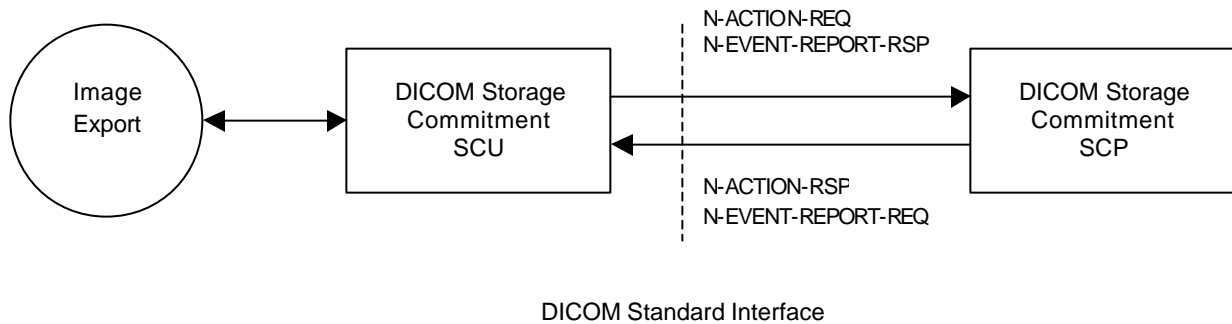
2.1.6 Storage Commitment

DICOM Storage Commitment is embedded in the successful completion of a study store to a DICOM Store SCP. It is dynamically negotiated when all images have been successfully stored to a server. If the host supports C-STORE of a Structured Report object, Sequoia includes an SR SOP instance UID in the Storage Commitment N-ACTION request and will process the N-EVENT-REPORT for the SR SOP instance.

Sequoia uses the DICOM Storage Commitment Push Model to inform the server when all stores for a study have been completed. The Storage Commitment SCU uses the N-ACTION primitive to make a request to the SCP for safekeeping of a set of SOP instances (eg: Ultrasound images).

The Sequoia Storage Commitment SCU also performs a role reversal and becomes the SCP for the N-EVENT-REPORT primitives received from the original SCP (now an SCU).

Figure 2.1.6-1 Storage Commitment Model



2.1.7 DICOM MOD Media Interchange

The DICOM MOD Media Interchange performs the following:

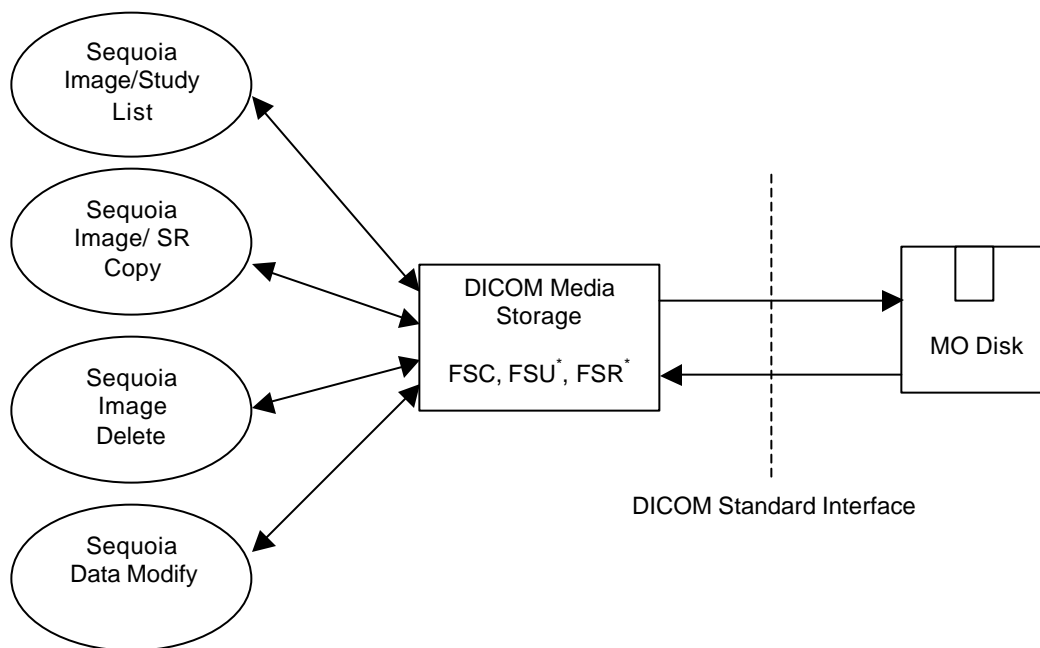
Table 2.1.7-1 DICOM Ultrasound Application Profiles

| Application Profile | Real-World Activity | Role |
|---------------------|---------------------|-------------------|
| STD-US-SF-MOD128 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD128 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-SF-MOD230 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD230 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-SF-MOD540 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD540 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-SF-MOD640 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD640 | Create MO | FSC, [FSU*, FSR*] |

* Updater/Reader only applicable to Sequoia & Aspen systems

- File-set creator (FSC): it creates a DICOM MOD medium when the user copies studies/images to MO. A DICOM 3.0 conforming DICOMDIR file is created together with the directory structures and image files.
- Supported MO disk formats are 128MB, 230MB, 540MB, and 640MB
- The Sequoia disk drive may be either a 230MB drive or a 640MB drive.
- Sequoia creates a partitioned MOD if formatted on the system.
- File-set updater (FSU^{*}): it modifies the DICOMDIR file and image files when the user copies or deletes studies.
- File-set reader (FSR^{*}): it reads the DICOMDIR and makes a listing. The DICOMDIR file is read and parsed by the system Study Util user interface to generate the study listing.

Figure 2.1.7-2 DICOM MOD Media Interchange Model



Studies/images can be manually copied to MOD from the system local hard drive via the Sequoia Study Util user interface. The SR object is copied to and from the MOD and hard disk.

Studies/images can be manually copied to the system local hard drive from MOD via the Sequoia Study Util user interface. This is the only method to review previously stored studies from an MOD. A study can be displayed and reviewed once it has been copied to the hard drive.

Limitations:

- Only Acuson Aspen and Sequoia studies can be copied to and from MOD. An MOD can contain a mix of Aspen and Sequoia studies.

- Only Acuson Aspen and Sequoia created studies can be reviewed on Sequoia.
- The Aspen release version must be 3.0 or greater.
- The Sequoia release version must be 1.0 or greater.

The level of compatibility of Sequoia 7.0 DICOM MODs with a non-Acuson DICOM 3.0 reader must be assessed by the maker of the reader.

2.2 AE Functional Definition

2.2.1 Verification Real-World Activities

The Sequoia application entity performs Verification Service Class as SCU and SCP thus allowing the operator to verify the ability of an application on a remote node to receive DICOM messages.

2.2.2 Image Export Real-World Activities

The Sequoia application entity performs all of the functions to transmit ultrasound images and associated data to network servers and/or workstations. The Sequoia AE supports both Ultrasound Image and Ultrasound Multi-frame Image Store SOP classes as an SCU.

2.2.3 Image Print Real-World Activities

The Sequoia AE provides all aspects of the Print Management SCU. The AE initiates separate associations to the print server. The Sequoia AE accommodates both grayscale and color print servers.

2.2.4 Modality Worklist Real-World Activities

The Sequoia AE supports the DICOM Basic Worklist Management Service as an SCU. The AE initiates an association to the active Worklist server when a Worklist query is selected (via the “Query” softkey) or when Sequoia is configured for Pre-fetch. The association is closed upon the completion of each query.

2.2.5 Modality Performed Procedure Step Real-World Activities

The Sequoia AE supports Modality Performed Procedure Step (MPPS) in the role of SCU.

2.2.6 Storage Commitment Real-World Activities

The Sequoia AE supports Storage Commitment Push Model SOP class to inform servers when all the store operations for a study have been completed. The Storage Commitment SCU uses the N-ACTION primitive to request safekeeping of a set of SOP Instances (Ultrasound Images and SR objects). The Storage Commitment SCU also processes the N-EVENT-REPORT primitives that are received from the SCP indicating ‘successful’ or ‘non-successful’ commitment status. Currently the N-EVENT-REPORT information is not being used to mark ‘eligible’ images for deletion from the Sequoia hard drive. This will be implemented in some future release.

2.2.7 DICOM MOD Media Interchange Real-World Activities

The Sequoia AE supports the DIOCM MOD Media Interchange. The supported MO disk formats Sequoia currently can write are 128MB, 230MB, 540MB, and 640MB. Note that Sequoia can only read studies that were generated from Aspen or Sequoia systems – it cannot read from other vendors' disks.

3. AE Specifications

The following specifications apply to the AE as depicted in Figure 2.1.7-1 on page 5.

3.1 Sequoia AE Specification

The Sequoia AE provides conformance to the following DICOM Service SOP Classes as an SCU:

Table 3.1-1 Supported SOP Classes

| Service SOP Class Name | SOP Class UID |
|--|-------------------------------|
| Verification | 1.2.840.10008.1.1 |
| Ultrasound Image Storage | 1.2.840.10008.5.1.4.1.1.6.1 |
| Ultrasound Image Storage (Retired) | 1.2.840.10008.5.1.4.1.1.6 |
| Ultrasound Multi-frame Image Storage | 1.2.840.10008.5.1.4.1.1.3.1 |
| Ultrasound Multi-frame Image Storage (Retired) | 1.2.840.10008.5.1.4.1.1.3 |
| Secondary Capture Image Storage | 1.2.840.10008.5.1.4.1.1.7 |
| Basic Grayscale Print Management Meta | 1.2.840.10008.5.1.1.9 |
| Basic Color Print Management Meta | 1.2.840.10008.5.1.1.18 |
| Storage Commitment Push Model | 1.2.840.10008.1.20.1 |
| 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 |
| Structured Report (Acuson) | 1.2.840.10008.5.1.4.1.1.88.3* |

* Note – This SOP Class Name is a private Structure Reporting (SR) SOP Class used only by the Acuson ultrasound platforms. This SR SOP Class was implemented before the official DICOM standard's Structure Reporting was finalized. At the time of implementation, the DICOM Standard root ID was incorrectly used instead of the Acuson root ID. Currently the DICOM standard is not using this specific SOP Class UID. The Acuson ultrasound platform has not yet changed the SR SOP Class ID due to backwards compatibility issues for existing customer studies.

3.1.1 Association Establishment Policies

3.1.1.1 General

The Acuson Sequoia system uses TCP/IP. The Maximum Length PDU negotiation is included in all association establishment requests. The maximum length PDU offered for an association initiated by Sequoia is 32768 bytes. However if the receiver negotiates a lower value then the Sequoia will use the lower value. Note that the receiver must negotiate at least a minimum of 128 bytes.

3.1.1.2 Number of Associations

Multiple associations can be opened for the same or different types of transactions. The maximum number of simultaneous associations is 10.

This implementation will initiate the association in the following manner.

- The Verification SCU opens one association. It is closed at the end of the transaction.
- The Storage SCU will open a variable number of associations, possibly overlapping, in background storage modes*. There is one association in bulk storage mode per one or more studies.
- The Storage Commitment SCU and the subsequent SCP opens one association each in background storage modes. There is one association in bulk storage mode.
- The Print SCU opens one association per film session.

*It is possible to also configure the Sequoia, by way of the Network Configuration menu, to allow only serial associations with a Store SCP that does not support overlapping associations.

3.1.1.3 Asynchronous Nature

All associations use the default synchronous mode of operation. Asynchronous Operations Window negotiations are not supported on the Sequoia.

3.1.1.4 Implementation Identifying Information

Implementation Class UID: "1.2.840.113680.21.1" (See below)

Implementation Version Name: "DS21.1_S_7_0"

Where the DS21.1 is the DICOM stack version and the S_7_0 is the Sequoia software version.

Siemens has provided registration for all Siemens Medical Systems Groups. The unique Class UID for the Acuson product is defined as: "1.2.840.113680"

Where the interpretation is:

1. = International Standards Organization (ISO)
2. = ANSI member body
840. = Country Code (United States)
- 113680 = ANSI Registered number assigned to Acuson products

3.1.1.5 Calling and Called AE Titles

The SCU Calling AE Title is pre-configured at the installation time to be:

- SEQUOIA_serial#

This is modifiable in the Sequoia configuration if necessary.

The “Called AE Title” is used by a SCP. This Sequoia release does not contain a SCP, (except in its role reversal in the Storage Commitment SOP Class).

3.1.2 Association Initiation by Real-World Activities

3.1.2.1 Real World Activity – Verification

The Sequoia is capable of supporting Verification service class as an SCU and SCP. Verification can be initiated in the Network Configuration window under the SUI menu.

3.1.2.1.1. Proposed Presentation Contexts – Verification

The Sequoia will propose Presentation context as shown in the following table:

Table 3.1.2.1.1-1 Verification Presentation Context Table

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

3.1.2.2 Real World Activity – Store

When images are transferred to a DICOM Store SCP, the system establishes an association between the Sequoia AE and the identified DICOM device (i.e. Network Archive Server, Workstation Server).

The Sequoia system can be configured to send studies in one of the following ways:

1. In-Progress
2. On Study Close
3. Study Utils (Bulk Store)

When studies are sent using “In-Progress”, individual images are sent to the store device as they are acquired. In the “On Study Close” all images are sent at the end of the study. Finally the Study Utils Bulk Store is used to store one or more studies from a list of studies.

3.1.2.2.1. Proposed Presentation Context

The following Presentation Context(s) is presented to the SCP in an A-Associate request for DIMSE C-STORE storage services. The storage services utilize C-STORE services, whose parameters are defined in PS 3.7 (Table 9.1-1). The following Presentation Context applies to all three Sequoia store modes:

Table 3.1.2.2.1-1 Store Presentation Context Table

| Presentation Context Table | | | | | |
|--|------------------------------|---------------------------|------------------------|------|----------------------|
| Abstract Syntax | | Transfer Syntax | | Role | Extended Negotiation |
| Name | UID | Name List | UID List | | |
| Ultrasound Image Storage | 1.2.840.10008.5.1.4.1.1.6.1 | RLE Lossless | 1.2.840.10008.1.2.5 | SCU | None |
| Ultrasound Image Storage | 1.2.840.10008.5.1.4.1.1.6.1 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |
| Ultrasound Image Storage (Retired) | 1.2.840.10008.5.1.4.1.1.6 | RLE Lossless | 1.2.840.10008.1.2.5 | SCU | None |
| Ultrasound Image Storage (Retired) | 1.2.840.10008.5.1.4.1.1.6 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |
| Ultrasound Multi-frame Image Storage | 1.2.840.10008.5.1.4.1.1.3.1 | JPEG Baseline | 1.2.840.10008.1.2.4.50 | SCU | None |
| Ultrasound Multi-frame Image Storage | 1.2.840.10008.5.1.4.1.1.3.1 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |
| Ultrasound Multi-frame Image Storage (Retired) | 1.2.840.10008.5.1.4.1.1.3 | JPEG Baseline | 1.2.840.10008.1.2.4.50 | SCU | None |
| Ultrasound Multi-frame Image Storage (Retired) | 1.2.840.10008.5.1.4.1.1.3 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |
| Secondary Capture Image Storage | 1.2.840.10008.5.1.4.1.1.7 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |
| Structured Report (Acuson) | 1.2.840.10008.5.1.4.1.1.88.3 | Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |

The Sequoia system always acts as an SCU and is the client in a client-server model. The system will negotiate associations in the following order: New US IOD, Retired US IOD, and Secondary Capture.

Sequoia sends SOP class UID and transfer syntax UID pairs to negotiate for supported presentation contexts in the following method:

- SOP class UID 1 and Transfer Syntax UID 1
- SOP class UID 1 and Transfer Syntax UID 2
- SOP class UID 2 and Transfer Syntax UID 1

...

This may pose problems to servers that can only recognize the following method of grouping:

- SOP class UID 1 and Transfer Syntax UID 1, Transfer Syntax UID 2
- SOP class UID 2 and Transfer Syntax UID 1, ...

3.1.2.2.2. Photometric Interpretation

Photometric Interpretation (color mode of the pixel image data) is not a negotiable parameter in DICOM 3.0. This implementation exports color images in RGB mode and grayscale images in Monochrome 2 if the peer AE accepts only uncompressed Implicit VR Little Endian transfer syntax. It is also possible to manually configure the ultrasound system to export color images as Monochrome 2. This is done by enabling the Grey Store service in the Network Configuration menu (SUI).

If the peer AE accepts either RLE or JPEG compression transfer syntax, images are exported in a YBR color mode (see Table 4.1.2.2.2-1).

Table 3.1.2.2.2-1 Photometric Interpretation of Exported Images

| Ultrasound Image SOP Class UID | Transfer Syntax and UID | Image Content | User Config | Photometric Interpretation |
|--|---|---------------|-------------|----------------------------|
| Single-frame: 1.2.840.10008.5.1.4.1.1.6.1 1.2.840.10008.5.1.4.1.1.6 1.2.840.10008.5.1.4.1.1.7 | Implicit VR Little Endian 1.2.840.10008.1.2 | B/W | n/a | MONOCHROME2 |
| Multi-frame: 1.2.840.10008.5.1.4.1.1.3.1 1.2.840.10008.5.1.4.1.1.3 | | Color | B/W | MONOCHROME2 |
| | | | | RGB |
| Single-frame: 1.2.840.10008.5.1.4.1.1.6.1 | RLE Lossless Compression 1.2.840.10008.1.2.5 | B/W or Color | B/W or RGB | YBR_FULL |
| Multi-frame: 1.2.840.10008.5.1.4.1.1.3.1 | JPEG Baseline Compression 1.2.840.10008.1.2.4.50 | B/W or Color | B/W or RGB | YBR_FULL_422 |

3.1.2.2.3. Storage SOP Classes: DICOM IOD Specification

This implementation uses DICOM 3.0 Part 3 as the DICOM Image IOD specification. All Type 1 and 2 elements specified in the DICOM 3.0 standard are encoded and exported. Some Type 3, 1C and 2C elements are also exported.

The following table denotes the attributes included in the Ultrasound Image Object as implemented on the Sequoia. Attributes not listed are not used.

Table 3.1.2.2.3-1 US Image IOD Attributes used

| Module | Attribute | Tag | Notes |
|-------------------|------------------------------------|-------------|--|
| Patient | Patient Name | (0010,0010) | Sequoia Begin Screen – First, Last, Prefix, & Suffix fields. Default is NULL. |
| | Patient ID | (0010,0020) | Sequoia Begin Screen – Patient ID field. Default is Snnnnn.xxxxxxxx where nnnnn is system serial number and xxxxxxxx is a Unix time stamp. |
| | Patient’s Birth Date | (0010,0030) | Sequoia Begin Screen – DOB field. Default is NULL. |
| | Patient Sex | (0010,0040) | Sequoia Begin Screen – Sex field. M = Male, F = Female. Default is NULL. |
| | Other Patient Ids | (0010,1000) | Sequoia Begin Screen – SSN field. Default is NULL. |
| | Patient Comments | (0010,4000) | Sequoia Begin Screen – Comment field. Default is NULL. |
| General Study | Study Instance UID | (0020,000D) | |
| | Study Date | (0008,0020) | The date when the Sequoia was entered into the Begin Screen. |
| | Study Time | (0008,0030) | The time when the Sequoia was entered into the Begin Screen |
| | Referring Physician’s Name | (0008,0090) | Sequoia Begin Screen – Referring Physician field. Default is NULL. |
| | Study ID | (0020,0010) | Sequoia Begin Screen – Value is set to the Study Type selected. |
| | Accession Number | (0008,0050) | Sequoia Begin Screen – Accession Field. Default is NULL. |
| | Study Description | (0008,1030) | Sequoia Begin Screen – Value is set to the Study Type selected for the study. |
| | Name of Physician(s) Reading Study | (0008,1060) | Sequoia Begin Screen – Diagnosing Physician field. Default is NULL. |
| Patient Study | Patient’s Age | (0010,1010) | Sequoia Begin Screen – Age field. Default is NULL. |
| | Patient’s Size | (0010,1020) | Sequoia Begin Screen – Height field. Default is NULL. |
| | Patient’s Weight | (0010,1030) | Sequoia Begin Screen – Weight field. Default is NULL. |
| General Series | Modality | (0008,0060) | Set to “US” |
| | Series Instance UID | (0020,000E) | |
| | Series Number | (0020,0011) | Set to “1” |
| | Operator Name | (0008,1070) | Sequoia Begin Screen – Sonographer field. Default is NULL. |
| General Equipment | Manufacturer | (0008,0070) | Set to “ACUSON” |
| | Institution Name | (0008,0080) | Sequoia Setup (Screen Options) – Institution field. Default is NULL. |
| | Station Name | (0008,1010) | Sequoia Begin Screen – Machine ID. Default is NULL. |
| | Institutional Department Name | (0008,1040) | Sequoia Begin Screen – Department field. Default is NULL. |
| | Manufacturer’s Model Name | (0008,1090) | Set to “SEQUOIA” |

| | | | |
|----------------------------|--------------------------------|-------------------|---|
| | Device Serial Number | (0018,1000) | Set to Sequoia's serial number. |
| | Software Versions | (0018,1020) | Set to "7.0" |
| General Image | Image Number | (0020,0013) | Image number in study (1 – n). |
| | Patient Orientation | (0020,0020) | Set to NULL. |
| | Image Date | (0008,0023) | Date the image was captured. |
| | Image Time | (0008,0033) | Time the image was captured. |
| | Images in Acquisition | (0020,1002) | Number of images that resulted from the study (1-n). |
| | Lossy Image Compression | (0028,2110) | Set to "00" for single-frame images, "01" for multi-frame images. |
| | Image Pixel | Samples per Pixel | (0028,0002) |
| Photometric Interpretation | | (0028,0004) | Set to the following: RGB = Uncompressed color images (single- or multi-frame), MONOCHROME2 = Uncompressed b/w images (single- or multi-frame), YBR_FULL = Compressed single-frame images (color or b/w), YBR_FULL_422 = Compressed multi-frame images (color or b/w) |
| Rows | | (0028,0010) | Set to 480 for full size images and 240 for ¼ size images. (NTSC) Set to 576 for full size images and 288 for ¼ size images. (PAL) |
| Columns | | (0028,0011) | Set to 640 for full size images and 320 for ¼ size images. (NTSC) Set to 768 for full size images and 384 for ¼ size images. (PAL) |
| Bits Allocated | | (0028,0100) | Set to 8 |
| Bits Stored | | (0028,0101) | Set to 8 |
| High Bit | | (0028,0102) | Set to 7 |
| Pixel Representation | | (0028,0103) | Set to 0000H = Unsigned integer |
| Pixel Data | | (7FE0,0010) | |
| Planar Configuration | | (0028,0006) | Indicates whether the pixel data are sent color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. Enumerated values are: 0000H = Color-by-pixel 0001H = Color-by-plane Sequoia sets to: 0000H for multi-frame images, 0001H for single-frame images. |
| Multi-frame | Number of frames | (0028,0008) | |
| | Frame Increment Pointer | (0028,0009) | Set to (0018,1065) |
| US Region Calibration | Sequence of Ultrasound Regions | (0018,6011) | |

| | | | |
|--|------------------------------|-------------|--|
| | >Region Location Min x_0 | (0018,6018) | |
| | >Region Location Min y_0 | (0018,601A) | |
| | >Region Location Max x_1 | (0018,601C) | |
| | >Region Location Max y_1 | (0018,601E) | |
| | >Physical Units X Direction | (0018,6024) | Physical units of the dimensions of the region. Applicable values are: 0000H = None 0003H = cm 0004H = seconds 0007H = cm/seconds |
| | >Physical Units Y Direction | (0018,6026) | Physical units of the dimensions of the region. Applicable values are: 0000H = None 0003H = cm 0004H = seconds 0007H = cm/seconds |
| | >Physical Delta X | (0018,602C) | |
| | >Physical Delta Y | (0018,602E) | |
| | >Reference Pixel x_0 | (0018,6020) | |
| | >Reference Pixel y_0 | (0018,6022) | |
| | >Ref. Pixel Physical Value X | (0018,6028) | |
| | >Ref. Pixel Physical Value Y | (0018,602A) | |
| | >Region Spatial Format | (0018,6012) | The spatial organization of the data within the region. Possible values: 0000H = None 0001H = 2-D (tissue or flow) 0002H = M-Mode (tissue or flow) 0003H = Spectral (CW or PW Doppler) 0004H = Wave form (physiological traces, Doppler traces,...) 0005H = Graphics |
| | >Region Data Type | (0018,6014) | The type of data within the region. Possible values: 0000H = None 0001H = Tissue 0002H = Color Flow 0003H = PW Spectral Doppler 0004H = CW Spectra Doppler 0005H = Doppler Mean Trace 0006H = Doppler Mode Trace 0007H = Doppler Max Trace 0008H = Volume Trace 0009H = d(volume)/dt Trace 000AH = ECG Trace 000BH = Pulse Trace 000CH = Phonocardiogram Trace 000DH = Gray bar 000EH = Color bar 000FH = Integrated Backscatter 0010H = Area Trace 0011H = d(area)/dt 0012H = Other Physiological (Amplitude vs. Time) input |

| | | | |
|----------|-----------------------------------|-------------|--|
| | >Region Flags | (0018,6016) | <p>Flags used for special handling of the region.</p> <p>Bit 0 – Transparency: 1 = Transparent 0 = Opaque</p> <p>Bit 1 – Scaling Protection: 1 = Protected 0 = Not Protected</p> <p>Bit 2 – Doppler Scale Type 1 = Frequency 0 = Velocity</p> |
| | >Doppler Correction Angle | (0018,6034) | |
| | >Doppler Sample Volume X Position | (0018,6038) | |
| | >Doppler Sample Volume Y Position | (0018,603A) | |
| | >TM-Line Position x_0 | (0018,603C) | |
| | >TM-Line Position Y_0 | (0018,603E) | |
| | >TM-Line Position x_1 | (0018,6040) | |
| | >TM-Line Position Y_1 | (0018,6042) | |
| US Image | Image Type | (0008,0008) | <p>This tag has four values associated with it. The first two values are set as follows:</p> <p>The First value is “ORIGINAL\PRIMARY” if the image is not a recaptured image.</p> <p>The Second value is “DERIVED\PRIMARY” if the image is a ¼ size rendition of the original full size image.</p> <p>“DERIVED\SECONDARY” if the image is a recaptured image.</p> <p>The Third value is set to NULL.</p> <p>The Fourth value is constructed as a bit map to allow for a description of multi-mode displays. In using this bit map, the sum of the values of the various modalities will unambiguously determine the constituent mode displays:</p> <p>0001 = 2-D 0002 = M-MODE 0004 = CW DOPPLER 0008 = PW DOPPLER 0010 = COLOR DOPPLER 0020 = COLOR M-MODE 0040 = 3-D</p> |

| | | | |
|--|--------------------------|-------------|--|
| | Stage Name | (0008,2120) | <p>A Stage is a particular time interval of a protocol during which a set of images are collected. The names can be free form text. Recommended text for Stress Echo stage names are:</p> <p>PRE_EXERCISE POST-EXERCISE PEAK-EXERCISE RECOVERY BASELINE LOW DOSE PEAK DOSE</p> |
| | Stage Number | (0008,2122) | A number that identifies the Stage. Stage numbers start at one. |
| | Number of Stages | (0008,2124) | Number of Stages in this protocol. Required if image was acquired in a Stage protocol |
| | View Number | (0008,2128) | A number that identifies the View. View numbers start at one. |
| | Number of Event Timers | (0008,2129) | Number of Event Timers used at the time of acquisition of a multi-frame image |
| | Number of Views in Stage | (0008,212A) | Number of views in this stage. Required if image was acquired in a Staged Protocol |
| | Event Elapsed Time(s) | (0008,2130) | An array of values associated with each Event Timers. Units in milliseconds. |
| | Event Timer Name(s) | (0008,2132) | Name(s) that identifies the Event Timer(s). |
| | Start Trim | (0008,2142) | The frame number of the first frame of the multi-frame image to be displayed. |
| | Stop Trim | (0008,2143) | The frame number of the last frame of a multi-frame image to be displayed. |
| | Trigger Time | (0018,1060) | Time interval measured in msec from the start of the R-wave to the beginning of data taking. |
| | Frame Time Vector | (0018,1065) | An array which contains the real time increments (in msec) between frames for a multi-frame image. |
| | Heart Rate | (0018,1088) | Beats per minute |
| | Transducer Data | (0018,5010) | Set to model number of Transducer |
| | Transducer Type | (0018,6031) | |

| | | | |
|------------|------------------------|-------------|---|
| SOP Common | SOP Class UID | (0008,0016) | Possible values are: 1.2.840.10008.5.1.4.1.1.6.1 Ultrasound Image Storage 1.2.840.10008.5.1.4.1.1.6 Ultrasound Image Storage (Retired) 1.2.840.10008.5.1.4.1.1.3.1 Ultrasound Multi-frame Image Storage 1.2.840.10008.5.1.4.1.1.3 Ultrasound Multi-frame Image Storage (Retired) 1.2.840.10008.5.1.4.1.1.7 Secondary Capture 1.2.840.10008.5.1.4.1.1.88.3 Structured Report (Acuson) |
| | SOP Instance UID | (0008,0018) | |
| | Specific Character Set | (0008,0005) | Set to "ISO_IR 100" |

The Sequoia system can be configured to send Acuson private elements that are used to support the KinetDx and Perspective systems. These Acuson private elements include elements from both 0x0009 and 0x7FDF group tags. The data for these Acuson private elements are parsed out from the Sequoia study's proprietary ACQ_SET, CLIPS/IMAGES, and DBRECORD files (see section 6.1).

3.1.2.3 Real World Activity – Print

When print is initiated either by background (On Study Close/In Progress) or foreground (Study Utils) printing, an association with the assigned DICOM Printer/Print Server is made.

3.1.2.3.1. Proposed Presentation Context to a Grayscale Printer

Table 3.1.2.3.1-1 Grayscale Print Presentation Context Table

| Presentation Context Table | | | | | |
|---|-----------------------|---------------------------------|-------------------|------|----------------------|
| Abstract Syntax | | Transfer Syntax | | Role | Extended Negotiation |
| Name | UID | Name List | UID List | | |
| Basic Grayscale Print Management Meta SOP Class | 1.2.840.10008.5.1.1.9 | DICOM Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |

Table 3.1.2.3.1-2 Basic Grayscale Print Management Meta SOP Classes

| SOP Class Name | SOP Class UID |
|-------------------------------------|------------------------|
| Basic Film Session SOP Class | 1.2.8.40.10008.5.1.1.1 |
| Basic Film Box SOP Class | 1.2.8.40.10008.5.1.1.2 |
| Basic Grayscale Image Box SOP Class | 1.2.8.40.10008.5.1.1.4 |

3.1.2.3.2. Basic Film Session SOP Class

Table 3.1.2.3.2-1 Basic Film Session SOP Class

| Attribute Name | Attribute Tag | Range | Description |
|--------------------|---------------|----------------------------------|---|
| Number of Copies | (2000,0010) | 1 to 99 | Number of requested film copies |
| Print Priority | (2000,0020) | HIGH, MED, LOW | Set at configuration |
| Medium Type | (2000,0030) | PAPER BLUE FILM CLEAR FILM | Media used for hardcopy; may be further limited by printer/print server |
| Film Destination | (2000,0040) | PROCESSOR | May be further limited by printer/print server |
| Film Session Label | (2000,0050) | SEQUOIA IMAGE | |

Sequoia uses the following DIMSE Services for the Basic Film Session SOP Class:
N-CREATE - Creates the Film Session

3.1.2.3.3. Basic Film Box SOP Class

Table 3.1.2.3.3-1 Basic Film Box SOP Class

| Attribute Name | Attribute Tag | Range | Description |
|----------------------|---------------|--|--|
| Image Display Format | (2010,0010) | STANDARD\1,1 STANDARD\1,2 STANDARD\2,2 STANDARD\2,3 STANDARD\3,3 STANDARD\3,4 STANDARD\3,5 STANDARD\4,4 STANDARD\4,5 STANDARD\4,6 STANDARD\5,3 STANDARD\5,4 STANDARD\5,6 | May be further limited by printer/print server |
| Film Orientation | (2010,0040) | PORTRAIT LANDSCAPE | May be further limited by printer/print server |
| Film Size ID | (2010,0050) | 8INX10IN 14INX17IN 10INX12IN 10INX14IN 11INX14IN 14INX14IN 24CMX24CM 24CMX30CM | May be further limited by printer/print server |
| Magnification Type | (2010,0060) | n/a | Tag not sent by Sequoia |
| Minimum Density | (2010,0120) | 0 or higher | Printer specific |
| Maximum Density | (2010,0130) | 350 or lower | Printer specific |
| Border Density | (2010,0100) | BLACK | |

| | | | |
|---------------------|-------------|----------------|--|
| | | WHITE | |
| Empty Image Density | (2010,0110) | BLACK WHITE | |
| Trim | (2010,0140) | YES NO | |

Sequoia uses the following DIMSE Services for the Basic Film Box SOP Class:

N-CREATE - Creates the Film Box

N-DELETE - Deletes the Film Box. Issued after each film is printed

N-ACTION - PRINT. Sent after each Film Box is filled or to force a print of partially filled Film Box

3.1.2.3.4. Basic Film Grayscale Image Box SOP Class

Table 3.1.2.3.4-1 Basic Film Grayscale Image Box SOP Class

| Attribute Name | Attribute Tag | Range | Description |
|--------------------------------|---------------|---------------------------------|-------------|
| Image Position | (2020,0010) | | |
| Polarity | (2020,0020) | | |
| Basic Grayscale Image Sequence | (0028,0002) | | |
| >Samples Per Pixel | (0028,0002) | Set to 1 | |
| >Photometric Interpretation | (0028,0004) | Set to MONOCHROME2 | |
| >Rows | (0028,0010) | Set to 480 NTSC / 576 PAL | |
| >Columns | (0028,0011) | Set to 640 NTSC / 768 PAL | |
| >Pixel Aspect Ratio | (0028,0034) | Set to 1 \ 1 | |
| >Bits Allocated | (0028,0100) | Set to 8 | |
| >Bits Stored | (0028,0101) | Set to 8 | |
| >High Bit | (0028,0102) | Set to 7 | |
| >Pixel Representation | (0028,0103) | Set to 0000H = Unsigned integer | |
| >Pixel Data | (7FE0,0010) | | |

Sequoia uses the following DIMSE Services for the Basic Grayscale Image Box SOP Class:

N-SET - Creates the individual images on the film.

3.1.2.3.5. Proposed Presentation Context to a Color Printer

Table 3.1.2.3.5-1 Color Print Presentation Context Table

| Presentation Context Table | | | | | |
|---|------------------------|---------------------------------|-------------------|------|----------------------|
| Abstract Syntax | | Transfer Syntax | | Role | Extended Negotiation |
| Name | UID | Name List | UID List | | |
| Basic Color Print Management Meta SOP Class | 1.2.840.10008.5.1.1.18 | DICOM Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |

Table 3.1.2.3.5-2 Basic Color Print Management Meta SOP Classes

| SOP Class Name | SOP Class UID |
|---------------------------------|--------------------------|
| Basic Film Session SOP Class | 1.2.8.40.10008.5.1.1.1 |
| Basic Film Box SOP Class | 1.2.8.40.10008.5.1.1.2 |
| Basic Color Image Box SOP Class | 1.2.8.40.10008.5.1.1.4.1 |

3.1.2.3.6. Basic Film Color Image Box SOP Class

The Basic Color Image Box SOP Class makes identical use of the Basic Film Session SOP Class and Basic Film Box SOP Class elements, which have been previously described for grayscale image printing. Therefore these will not be described again in this section on color printing. However, it should be noted that certain attributes, such as Medium Type, which is defined in the Basic Film Session SOP Class, are highly likely to require print/print server specific media.

Table 3.1.2.3.6-1 Basic Film Color Image Box SOP Class

| Attribute Name | Attribute Tag | Range | Description |
|-----------------------------|---------------|---------------------------------|-------------|
| Image Position | (2020,0010) | | |
| Polarity | (2020,0020) | | |
| Basic Color Image Sequence | (2020,0111) | | |
| >Samples Per Pixel | (0028,0002) | Set to 3 | |
| >Photometric Interpretation | (0028,0004) | Set to RGB | |
| >Planar Configuration | (0028,0006) | Set to 0 | |
| >Rows | (0028,0010) | Set to 480 NTSC / 576 PAL | |
| >Columns | (0028,0011) | Set to 640 NTSC / 768 PAL | |
| >Pixel Aspect Ratio | (0028,0034) | Set to 1 \ 1 | |
| >Bits Allocated | (0028,0100) | Set to 8 | |
| >Bits Stored | (0028,0101) | Set to 8 | |
| >High Bit | (0028,0102) | Set to 7 | |
| >Pixel Representation | (0028,0103) | Set to 0000H = Unsigned integer | |
| >Pixel Data | (7FE0,0010) | | |

Sequoia uses the following DIMSE Services for the Basic Color Image Box SOP Class:

N-SET - Creates the individual images on the film.

3.1.2.4 Real World Activity – Worklist

A separate network association is established by the AE for each worklist query operation, with only one active query at a time. The association is closed at completion of the query.

3.1.2.4.1. Proposed Presentation Context

Table 3.1.2.4.1-1 Worklist Presentation Context Table

| Presentation Context Table | | | | | |
|--|------------------------|---------------------------------|-------------------|------|----------------------|
| Abstract Syntax | | Transfer Syntax | | Role | Extended Negotiation |
| Name | UID | Name List | UID List | | |
| Modality Worklist Information Model – FIND | 1.2.840.10008.5.1.4.31 | DICOM Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |

The Sequoia system will always act as an SCU and be the client in a client-server model.

3.1.2.4.2. Modality Worklist Service SOP Class

The following table provides the list of attributes requested in the Modality Worklist Query:

Table 3.1.2.4.2-1 Modality Worklist Information Model Attributes

Attributes listed in **bold** are items that are available as query criteria from either the Begin screen, Worklist query screen or the Worklist Server setup screen.

| Module | Attribute Name | Tag | Match Type* | Notes |
|--------------------------|-------------------------------------|-------------|-------------|--|
| SOP Common | Specific Character Set | (0008,0005) | -- | Sequoia ignores this attribute. |
| Scheduled Procedure Step | Scheduled Procedure Step Sequence | (0040,0100) | SQ | |
| | > Scheduled Station AE title | (0040,0001) | UV | The user may set the value of this attribute under the “Filter Worklist” setting located in the Worklist Server setup menu. Possible values are: YES = AE Title of Sequoia NO = NULL value |

| | | | | |
|------------------------|--|-------------|----|---|
| | >Scheduled Procedure Step Start Date | (0040,0002) | DR | From the Begin page screen, Sequoia always sets this attribute to today's date. In the Worklist query screen, the user is allowed to select from the following ranges: Today 3Days 1Week All |
| | >Scheduled Procedure Step Start Time | (0040,0003) | DR | Set to NULL value |
| | >Modality | (0008,0060) | SV | The user may set the value of this attribute under the "Send U/S Study Only" setting located in the Worklist Server setup menu. Possible values are: YES = "US" NO = Any (NULL value) |
| | >Scheduled Performing Physician's Name | (0040,0006) | UV | |
| | >Scheduled Procedure Step Description | (0040,0007) | UV | This attribute is mapped to Sequoia's "Study Type" field on the Begin page. Sequoia ships with a list of study types. The Study Type names can be customized so that RIS and the ultrasound system have the same list to match correctly. |
| | >Scheduled Procedure Step ID | (0040,0009) | UV | |
| | >Comments on the Scheduled Procedure Step | (0040,0400) | UV | |
| Requested Procedure | Study Instance UID | (0020,000d) | UV | |
| | Requested Procedure ID | (0040,1001) | UV | |
| | Reason for Requested Procedure | (0040,1002) | UV | Maps to the Indication field in the Sequoia Begin Screen |
| | Requested Procedure Description | (0032,1060) | UV | |
| Image Service Request | Accession Number | (0008,0050) | SV | Maps to the Accession field in the Sequoia Begin Screen |
| | Referring Physician's Name | (0008,0090) | UV | Maps to the Ref. Physician field in the Sequoia Begin Screen |
| Patient Identification | Patient's Name | (0010,0010) | WC | Maps to the Patient Name field in the Sequoia Begin Screen |
| | Patient's ID | (0010,0020) | SV | Maps to the Patient ID field in the Sequoia Begin Screen |
| | Patient Other ID | (0010,1000) | UV | Maps to the SSN field in the Sequoia Begin Screen |
| Patient Demographic | Patient's Birth Date | (0010,0030) | UV | Maps to the DOB field in the Sequoia Begin Screen |
| | Patient Sex | (0010,0040) | UV | Maps to the Sex field in the Sequoia Begin Screen |

| | | | | |
|------------|------------------------------------|-------------|----|---|
| | Patient Size | (0010,1020) | UV | Maps to the Height field in the Sequoia Begin Screen |
| | Patient Weight | (0010,1030) | UV | Maps to the Weight field in the Sequoia Begin Screen |
| | Patient Comments | (0010,4000) | UV | Maps to the Comments field in the Sequoia Begin Screen |
| | Last Menstrual Date | (0010,21D0) | UV | |
| Study Read | Name of Physician(s) Reading Study | (0008,1060) | UV | Maps to the Diag. Physician field in the Sequoia Begin Screen. See Note 1 |

Note 1: These attributes are not part of the Modality Worklist Information Model, and are optional. Their support is not required by SCP's receiving Sequoia worklist queries.

| *Matching Key Types | |
|---------------------|-----------------------|
| SV | Single Value matching |
| WC | Wild Card matching |
| SQ | Sequence matching |
| UV | Universal matching |
| DR | Date Range matching |

3.1.2.5 Real World Activity – Modality Performed Procedure Step

3.1.2.5.1. Proposed Presentation Context

Table 3.1.2.5.1-1 MPPS Presentation Context Table

| Presentation Context Table | | | | | |
|-----------------------------------|-------------------------|---------------------------------|-------------------|------|----------------------|
| Abstract Syntax | | Transfer Syntax | | Role | Extended Negotiation |
| Name | UID | Name List | UID List | | |
| Modality Performed Procedure Step | 1.2.840.10008.3.1.2.3.3 | DICOM Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |

3.1.2.5.2. Modality Performed Procedure Step Service SOP Class

When the Sequoia captures the 1st image in a study, the Sequoia will send a N-CREATE service request. When the study is ended, Sequoia will send a N-SET service request.

The following table provides the list of attributes requested in the Modality Performed Procedure Step:

Table 3.1.2.5.2-1 MPPS Information Model Attributes
N-CREATE Service Request (Study Start with first image capture)

| Description/Module | Tag | Value Description |
|--------------------------------------|--------------|-------------------|
| Scheduled Procedure Step | | |
| Scheduled Step Attribute Sequence | (0040,0270) | |
| >Study Instance UID | (0020, 000D) | a |
| >Referenced Study Sequence | (0008, 1110) | null |
| >Accession Number | (0008, 0050) | a |
| >Requested Procedure ID | (0040, 1001) | a |
| >Requested Procedure Description | (0040, 0001) | a |
| >Scheduled Procedure Step ID | (0040, 0009) | a |
| >Scheduled Procedure Description | (0040, 0007) | a |
| >Scheduled Action Item Code Sequence | (0040, 0008) | null |
| Patient's Name | (0010, 0010) | |
| Patient's ID | (0010, 0020) | |
| Patient's Birth Date | (0010, 0030) | |
| Patient Sex | (0010, 0040) | |
| Referenced Patient Sequence | (0008,1120) | null |
| Performed Procedure Step Information | | |
| Performed Procedure Step ID | (0040,0253) | |
| Performed Station AE Title | (0040,0241) | |
| Performed Station Name | (0040,0242) | |
| Performed Location | (0040,0243) | null |
| Performed Procedure Step Start Date | (0040,0244) | |
| Performed Procedure Step Start Time | (0040,0245) | |
| Performed Procedure Step Status | (0040,0252) | "INPROGRESS" |
| Performed Procedure Step Description | (0040,0254) | null |
| Performed Procedure Type Description | (0040,0255) | null |
| Procedure Code Sequence | (0008,1032) | null |
| Performed Procedure Step End Date | (0040,0250) | null |
| Performed Procedure Step End Time | (0040,0251) | null |
| Image Acquisition Results | | |
| Modality | (0008,0060) | |
| Study ID | (0020,0010) | |
| Performed Action Item Code Sequence | (0040,0260) | null |
| Performed Series Sequence | (0040,0340) | null |

a. Uses relevant attributes from the Modality Worklist when available.

Table 3.1.2.5.2-2 MPPS Information Model Attributes
N-Set Service Request (Study End)

| Description/Module | Tag | Value Description |
|--------------------------------------|-------------|-------------------------------|
| Performed Procedure Step Information | | |
| Performed Procedure Step Status | (0040,0254) | "COMPLETED" or "DISCONTINUED" |
| Performed Procedure Step End Date | (0040,0250) | |
| Performed Procedure Step End Time | (0040,0251) | |
| Image Acquisition Results | | |
| Performed Series Sequence | (0040,0340) | |
| >Performing Physician's Name | (0008,1050) | null |
| >Protocol Name | (0018,1030) | "NONE" |
| >Operator's Name | (0008,1070) | |
| >Series Instance UID | (0020,000E) | |
| >Series Description | (0008,103E) | |
| >Retrieve AE Title | (0008,0054) | null |
| >Referenced Image Sequence | (0008,1140) | One for each clip/image |
| >>Referenced SOP Class UID | (0008,1150) | |
| >>Referenced SOP Instance UID | (0008,1155) | |
| >Referenced Stand-alone SOP Sequence | (0040,0220) | One for each SR Object |
| >>Referenced SOP Class UID | (0008,1150) | |
| >>Referenced SOP Instance UID | (0008,1155) | |

3.1.2.6 Real World Activity – Storage Commitment

3.1.2.6.1. Proposed Presentation Context

Table 3.1.2.6.1-1 Storage Commitment Presentation Context Table

| Presentation Context Table | | | | | |
|-------------------------------|----------------------|---------------------------------|-------------------|------|----------------------|
| Abstract Syntax | | Transfer Syntax | | Role | Extended Negotiation |
| Name | UID | Name List | UID List | | |
| Storage Commitment Push Model | 1.2.840.10008.1.20.1 | DICOM Implicit VR Little Endian | 1.2.840.10008.1.2 | SCU | None |

3.1.2.6.2. Storage Commitment Service SOP Class

The following table provides the list of attributes supported by the AE in the implementation of Storage Commitment SOP Class including N-ACTION, N-EVENT-REPORT, and File State attributes.

Table 3.1.2.6.2-1 Storage Commitment – Action Information

| Action Type Name | Action Type ID | Attribute | Tag | Description |
|----------------------------|----------------|------------------------------|-------------|---|
| Request Storage Commitment | 1 | Transaction UID | (0008,1195) | Sequoia Generated UID |
| | | Reference SOP Sequence | (0008,1199) | |
| | | >Referenced SOP Class UID | (0008,1150) | SOP Class UID for each object stored |
| | | >Referenced SOP Instance UID | (0008,1155) | SOP Instance UID for each object stored |

Table 3.1.2.6.2-2 Storage Commitment – Event Report Information

| Action Type Name | Action Type ID | Attribute | Tag | Description |
|--|----------------|------------------------------|-------------|-------------|
| Storage Commitment Request Successful | 1 | Transaction UID | (0008,1195) | |
| | | Reference SOP Sequence | (0008,1199) | |
| | | >Referenced SOP Class UID | (0008,1150) | |
| | | >Referenced SOP Instance UID | (0008,1155) | |
| Storage Commitment Request Complete Failures Exist | 2 | Retrieve AE Title | (0008,0054) | |
| | | Transaction UID | (0008,1195) | |
| | | Reference 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) | | | |

3.1.2.7 Real World Activity – MOD Media Interchange

The images that are stored on MO follow the same DICOM Image IOD specification as implemented in the DICOM 3.0 standard, Part 3 (see Table 3.1.2.2.3-1).

There is one limitation in regards to how Sequoia writes DICOM tags in the Image IOD between a network transfer and the MO disk. When Sequoia transfers images via the network, Sequoia includes all DICOM tags listed in Table 3.1.2.2.3-1. When Sequoia transfers images to MO, Sequoia excludes the following DICOM tags:

| Tag | Description |
|-------------|------------------------------------|
| (0010,1000) | Other Patient IDs |
| (0010,1020) | Patient's Size |
| (0010,1030) | Patient's Weight |
| (0008,1060) | Name of Physician(s) Reading Study |

| Tag | Description |
|-------------|-------------------------------|
| (0008,1070) | Operators' Name |
| (0010,4000) | Patient Comments |
| (0008,1010) | Station Name |
| (0008,1040) | Institutional Department Name |

However, these excluded tags are written to the MO via the Sequoia proprietary files (see section 6.1).

3.1.2.7.1. Ultrasound Application Profile

Table 3.1.2.7.1-1 DICOM Ultrasound Application Profiles

| Application Profile | Real-World Activity | Role |
|---------------------|---------------------|-------------------|
| STD-US-SF-MOD128 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD128 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-SF-MOD230 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD230 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-SF-MOD540 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD540 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-SF-MOD640 | Create MO | FSC, [FSU*, FSR*] |
| STD-US-MF-MOD640 | Create MO | FSC, [FSU*, FSR*] |

* Updater/Reader only applicable to Sequoia & Aspen systems

3.1.2.7.2. Proposed Presentation Context

Table 3.1.2.7.2-1 MOD Media Interchange Presentation Context Table

| Abstract Syntax | | Transfer Syntax | |
|--------------------------------------|-----------------------------|---------------------------|------------------------|
| Name | UID | Name List | UID List |
| Ultrasound Image | 1.2.840.10008.5.1.4.1.1.6.1 | RLE Lossless | 1.2.840.10008.1.2.5 |
| Ultrasound Multi-frame Image Storage | 1.2.840.10008.5.1.4.1.1.3.1 | JPEG Baseline | 1.2.840.10008.1.2.4.50 |
| DICOM Media Storage Directory | 1.2.840.10008.1.3.10 | Explicit VR Little Endian | 1.2.840.10008.1.2.1 |

4. Communication Profiles

4.1 TCP/IP Stack Supported

This implementation supports TCP/IP Protocol stack. OSI stack is not supported. This implementation is indifferent to the underlying physical medium. It only requires TCP/IP in the Transport and Network layers. Port number 2100 is used for DICOM communication with the Sequoia.

4.2 Physical Media Supported

Standard representation of IEEE 802.3 (10BaseT “twisted pair”) is supported and the system interfaces and transceivers configured to meet customer site-specific requirements.

5. Data Identification Information

Patient and image data originated from an Sequoia system can be identified by the Study Instance UID, Series Instance UID and SOP Instance UID, i.e., DICOM elements (0020, 000D), (0020, 000E) and (0008, 0018) in the IOD.

- Sequoia UID root is 1.2.840.113680.1.103
where:
1.2.840.113680 is the ANSI registered Acuson UID root.
- The Study Instance UID is composed using the following convention:
1.2.840.113680.1.103.n.s.t
where
n = serial number of the Sequoia machine
s = the UNIX epoch based time since a base time in seconds
t = microsecond within the second of current UNIX epoch-base time
- The Series Instance UID is composed of the Study Instance UID and the series number:
1.2.840.113680.1.103.n.s.t.r
where
r = 1 for full-screen static and dynamic and quarter-size static images
r = 2 for quarter-screen dynamic image
- The SOP Instance UID is composed of the Series Instance UID and the image number:
1.2.840.113680.1.103.n.s.t.r.f
where
f = image number

6. Extensions, Specializations and Privatizations

6.1 Private DICOM Elements

There are many DICOM Private tags used in Sequoia proprietary files internal to Sequoia software for image acquisition and image review on the Sequoia system and in the private Structured Report SOP object.

These can be exported to servers as part of the Store SCU AE configuration on the Sequoia system. They are also exported to removable MOD:

- ACQ_SET file: acquisition protocol and acquired image set information.
DICOM Private Elements, primarily (0009,xxxx)
- DSP_SET file: image set selected for display.
- CLIPS/IMAGES: Sequoia image data

Acuson private elements (7FDF, xxxx) in “Explicit VR Big Endian” file format

- CALC_SR: Sequoia measurements, calculations and findings for Cardiac, OB, and Vascular reports.
Various Acuson private, LOINC, and SNOMED elements
(The SR object is always stored if successfully negotiated in the Association negotiation.)

7. Configuration

The Sequoia Service User Interface database maintains configuration parameters for remote and local DICOM Application Entities. The parameters include:

- AE identification, i.e., a descriptive name
- Calling AE Title, IP address, and TCP port number (for Sequoia DICOM SCU)
- Called AE Title (for a remote SCP)
- TCP port number (for a remote SCP)
- IP address or host name (for a remote host where the remote SCP resides)
- DICOM print parameters for a DICOM print SCP entry
- Printer templates
- Some specialized information

This configuration database can be copied via a service MO to other Sequoia machines on the network.

The local DICOM applications read information from this database. The DICOM Network configuration tool is the only application that can modify this database.

8. Support of Extended Character Sets

The following character set is supported:

ISO-IR 100 Latin Alphabet No. 1

9. References

- Digital Imaging and Communication in Medicine (DICOM), NEMA Standard Publication No. PS 3.1~3.13, NEMA, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209, phone: (703)-841-3200.
- World Wide Web: <http://www.nema.org/medical/dicom.htm>

10. Glossary

| | |
|---------|--|
| ACR | American College of Radiology |
| AE | Application Entity |
| ANSI | American National Standards Institute |
| DICOM | Digital Imaging and Communication in Medicine |
| DIMSE-C | DICOM Message Service Element-Composite |
| DIMSE-N | DICOM Message Service Element-Normalized |
| FSC | File-set Creator |
| FSR | File-set Reader |
| FSU | File-set Updater |
| HIS/RIS | Hospital Information System/Radiology Information System |
| IOD | Information Object Definition |

| | |
|--------|---|
| ISO | International Standards Organization |
| MOD | Magneto-Optical Disk |
| NEMA | National Electrical Manufacturers Association |
| OSI | Open Systems Interconnections |
| PDU | Protocol Data Unit |
| SCP | Service Class Provider (server) |
| SR | Structured Report |
| SCU | Service Class User (client) |
| TCP/IP | Transmission Control Protocol/Internet Protocol |
| SOP | Service Object Pair |
| UID | Unique Identification |