

SYNAPSE

PACS

DICOM Conformance Statement

Document Version

– 14 –

Revision History

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Revision History

Document Version	Applicable Software Versions	Comments
03	Synapse2.2.1, 2.3.1	
04	Synapse3.0	
04.1	Updated for correction	Minor corrections
05	Synapse 3.1	New SOPs and Transfer syntaxes, new section for DICOM Query/Retrieve SCU
06	Synapse 3.1.1	Retrieve Synapse Diagnostic Report. More supported SOP classes for DicomSCU.
07	Synapse 3.2.0	MG CAD, C-FIND and MWL max rows, Added Requested Procedure Priority, Requesting Physician and Admission ID as MWL outputs. Removed Scheduled Procedure Step Protocol Code sequence from MWL output. Added comment on C-MOVE timeout for DICOM SCU. Sorted Appendix A table.
08	Synapse 3.2.1	Added C-STORE SCU, Pre-fetching Studies, and Media Management. Also added Series Description, Concept Name Code Sequence Code Value and Concept Name Code Sequence Coding Scheme Designator to Appendix A. Additional minor corrections.
09	Synapse 3.2.1 SR-320	Corrected an error: SC-MF-Color was listed with the wrong SOP Class UID for Query/Retrieve SCU
10	Synapse 3.2.1 SR-334	Added full support for GSPS and KOS, Site ID is returned for C-MOVE
11	Synapse 3.2.1 SR-347	Extended Structure Report support.
12	Synapse 3.2.1 SR-362	Added WADO conformance information, and supported DICOM Specific Audit Messages.
13	Synapse 4.0.0 Full Release	<i>NOTE: This change is on top of version 11. As such, neither WADO nor DICOM Specific Audit Messages are part of this version.</i> Added support for many new SOP Classes, Instance Root Level Retrieve (C-MOVE and C-GET modes), as well as C-GET for Study Root.
14	Synapse 4.1.0 Full Release	Added WADO conformance information, and supported DICOM Specific Audit Messages. <i>NOTE: This is a merge of version 12 changes which were excluded from version 13.</i>

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1. Introduction

This is a DICOM conformance statement for FUJIFILM Medical Systems USA's Synapse PACS System.

Synapse PACS system contains one or more instances of the DicomServer application which provides the necessary services as a DICOM Service Class Provider (SCP).

The Synapse Workstation also has the capability of querying/retrieving DICOM images from other DICOM SCP's to be viewed at the Workstation. In other words, the Synapse Workstation can act as a DICOM C-FIND and C-MOVE Service Class User (SCU).

The DICOM Print SCU capability is provided through a separate DICOM Printer driver, which installs a DICOM printer within the Windows operating system environment.

Synapse includes the capability of forwarding DICOM objects to a DICOM C-STORE SCP. When forwarding, Synapse acts as a DICOM C-STORE SCU.

Synapse can act as a Modality Worklist SCU to determine which patients have scheduled visits in the near future. Studies for those patients will then be retrieved and stored in a cache so that the Synapse Workstation can view while avoiding potentially long delays waiting for them to be retrieved from an SCP.

Synapse Workstation includes the capability to create DICOM file-sets on CD-R media.

2. Quick Summary

As Storage SCP			
SOP Class Name	SOP UID	Transfer Syntax UID	Comments
Verification	1.2.840.10008.1.1	1.2.840.10008.1.2	
Standard Storage	1.2.840.10008.5.1.4.1.1.29 (HGI) 1.2.840.10008.5.1.1.30 (HCI) 1.2.840.10008.5.1.4.1.1.1 (CR) 1.2.840.10008.5.1.4.1.1.1.1 (DX-Prs) 1.2.840.10008.5.1.4.1.1.1.1.1 (DX-Proc) 1.2.840.10008.5.1.4.1.1.2 (MG-Prs) 1.2.840.10008.5.1.4.1.1.2.1 (MG-Proc) 1.2.840.10008.5.1.4.1.1.3 (IO-Prs) 1.2.840.10008.5.1.4.1.1.3.1 (IO-Proc) 1.2.840.10008.5.1.4.1.1.2 (CT) 1.2.840.10008.5.1.4.1.1.3 (retUS-MF) 1.2.840.10008.5.1.4.1.1.3.1 (US-MF) 1.2.840.10008.5.1.4.1.1.4 (MR) 1.2.840.10008.5.1.4.1.1.4.2 (MRS) 1.2.840.10008.5.1.4.1.1.5 (retNM) 1.2.840.10008.5.1.4.1.1.6 (retUS) 1.2.840.10008.5.1.4.1.1.6.1 (US) 1.2.840.10008.5.1.4.1.1.7 (SC) 1.2.840.10008.5.1.4.1.1.7.1 (SC-MF-SB) 1.2.840.10008.5.1.4.1.1.7.2 (SC-MF-Byte) 1.2.840.10008.5.1.4.1.1.7.3 (SC-MF-Word) 1.2.840.10008.5.1.4.1.1.7.4 (SC-MF-Color) 1.2.840.10008.5.1.4.1.1.8 (STD OVLY) 1.2.840.10008.5.1.4.1.1.9 (STD CRV) 1.2.840.10008.5.1.4.1.1.10 (MOD LUT) 1.2.840.10008.5.1.4.1.1.11 (VOI LUT) 1.2.840.10008.5.1.4.1.1.12.1 (XA) 1.2.840.10008.5.1.4.1.1.12.2 (RF) 1.2.840.10008.5.1.4.1.1.12.3 (RF-BP) 1.2.840.10008.5.1.4.1.1.13.1.3 (MGT) 1.2.840.10008.5.1.4.1.1.20 (NM-MF) 1.2.840.10008.5.1.4.1.1.77.1 (VL) 1.2.840.10008.5.1.4.1.1.77.1.1 (ES) 1.2.840.10008.5.1.4.1.1.77.1.1.1 (ESV) 1.2.840.10008.5.1.4.1.1.77.1.2 (GM) 1.2.840.10008.5.1.4.1.1.77.1.3 (SM) 1.2.840.10008.5.1.4.1.1.77.1.4 (XC) 1.2.840.10008.5.1.4.1.1.77.2 (ESMF) 1.2.840.10008.5.1.4.1.1.128 (PET) 1.2.840.10008.5.1.4.1.1.481.1 (RTIMAGE)	Accepted Transfer Syntaxes: 1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2 1.2.840.10008.1.2.4.70 Additionally: 1.2.840.10008.1.2.4.50 for HCI, retUS-MF, US-MF, retUS, US, MR, SC, SC-MF-Byte, SC-MF-Word, SC-MF-Color, retNM, NM-MF, XA, RF, VL, ES, GM, SM, XC, ESMF. Additionally: 1.2.840.10008.1.2.5 for retUS-MF, US-MF, retUS, US. Only: 1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2 for STD OVLY, STD CRV, MOD LUT, VOI LUT, MRS, SC-MF-SB, ESV.	Explicit VR Little Endian recommended if Private Elements exist in the dataset Return codes = 0000, A700, C000

	1.2.840.10008.5.1.1.27 (SP) 1.2.840.10008.5.1.4.1.1.9.1.1 (12LECG) 1.2.840.10008.5.1.4.1.1.9.1.2 (GECG) 1.2.840.10008.5.1.4.1.1.9.1.3 (AECG) 1.2.840.10008.5.1.4.1.1.9.2.1 (HD) 1.2.840.10008.5.1.4.1.1.9.3.1 (EPS) 1.2.840.10008.5.1.4.1.1.9.4.1 (AU) 1.2.840.10008.5.1.4.1.1.11.1 (GSPS) 1.2.840.10008.5.1.4.1.1.11.2 (CSPS) 1.2.840.10008.5.1.4.1.1.11.3 (PCSPS) 1.2.840.10008.5.1.4.1.1.11.4 (BSPS) 1.2.840.10008.5.1.4.1.1.66 (RAW) 1.2.840.10008.5.1.4.1.1.88.11 (SR Basic Text) 1.2.840.10008.5.1.4.1.1.88.22 (SR Enhanced) 1.2.840.10008.5.1.4.1.1.88.33 (SR Comprehensive) 1.2.840.10008.5.1.4.1.1.88.50 (MG CAD SR) 1.2.840.10008.5.1.4.1.1.88.59 (KOS Document) 1.2.840.10008.5.1.4.1.1.88.65 (CCADSR) 1.2.840.10008.5.1.4.1.1.88.67 (DOSES SR) 1.2.840.10008.5.1.4.1.1.104.1 (PDF) 1.2.840.10008.5.1.4.1.1.129 (SPTCV) 1.2.840.10008.5.1.4.1.1.481.2 (RTDOSE) 1.2.840.10008.5.1.4.1.1.481.3 (RTSTRUCT) 1.2.840.10008.5.1.4.1.1.481.4 (RTBEAMS) 1.2.840.10008.5.1.4.1.1.481.5 (RTPLAN) 1.2.840.10008.5.1.4.1.1.481.6 (RTBRACHY) 1.2.840.10008.5.1.4.1.1.481.7 (RTSUMMARY) 1.2.840.10008.5.1.4.1.1.481.8 (RTION) 1.2.840.10008.5.1.4.1.1.481.9 (RTIONBEAMS)	Accepted Transfer Syntaxes: 1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2	
Fuji Private CR Storage	1.2.392.200036.9125.1.1.2	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2 1.2.840.10008.1.2.4.70	Return codes = 0000, A700, C000
Modality worklist-FIND	1.2.840.10008.5.1.4.31	1.2.840.10008.1.2	See Modality Worklist (Section 3.4) for details
Patient Root Q/R-FIND	1.2.840.10008.5.1.4.1.2.1.1	1.2.840.10008.1.2	Relational queries not supported
Study Root Q/R-FIND	1.2.840.10008.5.1.4.1.2.2.1	1.2.840.10008.1.2	Relational queries not supported
Patient/Study Q/R-FIND	1.2.840.10008.5.1.4.1.2.3.1	1.2.840.10008.1.2	Relational queries not supported
Patient Root Q/R-MOVE	1.2.840.10008.5.1.4.1.2.1.2	1.2.840.10008.1.2 1.2.840.10008.1.2.1	If the image is stored compressed and its transfer syntax negotiated, then this syntax will be used for transfer. Otherwise Explicit VR Little Endian will be tried first.
Study Root Q/R-MOVE	1.2.840.10008.5.1.4.1.2.2.2	If stored and negotiated: 1.2.840.10008.1.2.4.70 1.2.840.10008.1.2.4.50	
Study Root Q/R-GET	1.2.840.10008.5.1.4.1.2.2.3		
Patient/Study Q/R-MOVE	1.2.840.10008.5.1.4.1.2.3.2		
Composite Instance Root Retrieve – MOVE	1.2.840.10008.5.1.4.1.2.4.2		
Composite Instance Root Retrieve – GET	1.2.840.10008.5.1.4.1.2.4.3		
Composite Instance Retrieve Without Bulk Data – GET	1.2.840.10008.5.1.4.1.2.5.3	1.2.840.10008.1.2 1.2.840.10008.1.2.1	
Q/R-MOVE Synapse Diagnostic Report	1.2.840.10008.5.1.4.1.1.88.11	1.2.840.10008.1.2	Diagnostic report can be retrieved as Basic Structured report only on Study Query level along with the images.
Storage commitment push	1.2.840.10008.1.20.1	1.2.840.10008.1.2	See Storage Commitment

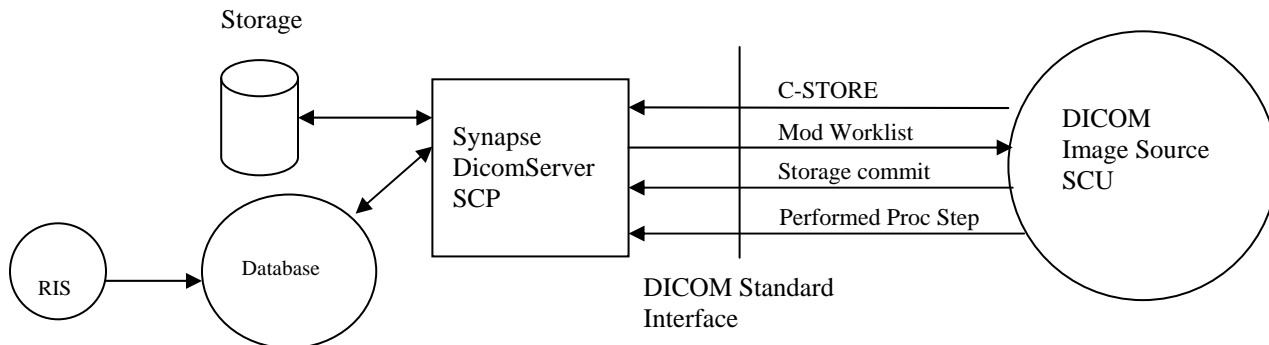
			(Section 3.5) for details
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3	1.2.840.10008.1.2	See Performed Procedure Step (Section 3.6) for details

- Storage SOP Classes have Level 2 (Full) conformance.
- SCP has Level 1 of Digital Signature support.
- Extended negotiations are not supported for any of the above service classes.
- There is no enforced limit on number of associations. System configuration (CPU, memory, Disk) may enforce practical limitations
- Only TCP/IP protocol is supported. Any physical media supporting the TCP/IP protocol is supported.
- AE Title, host (or IP address), port, and maximum PDU size are configurable.
- Implementation UID is 1.2.840.113845.1.1, Implementation version is the currently applicable Synapse software release version number.
- Extended character sets ARE supported
- Maximum number of rows the standard C-FIND and Modality Worklist will retrieve is:
 - 20,000 when involving multiple patients
 - Unlimited (no hard limit) when involving a single patient.
- Supported photometric interpretations: MONOCHROME1, MONOCHROME2, PALETTE COLOR, RGB, YBR_FULL, YBR_FULL_422
- Bits allocated greater than 16 are not supported.
- Pixels have to be right justified: $high_bit = bits_stored - 1$

As Print SCU:			
SOP Class Name	SOP UID	Transfer Syntax UID	Comments
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	1.2.840.10008.1.2	
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1	1.2.840.10008.1.2	N-CREATE, N-DELETE
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2	1.2.840.10008.1.2	N-CREATE, N-DELETE, N-ACTION
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.1.4	1.2.840.10008.1.2	N-SET
Printer SOP Class	1.2.840.10008.5.1.1.16	1.2.840.10008.1.2	N-GET
Print Job SOP Class	1.2.840.10008.5.1.1.14	1.2.840.10008.1.2	N-GET

As Query/Retrieve SCU:			
SOP Class Name	SOP UID	Transfer Syntax UID	Comments
STUDY ROOT Q/R FIND SCU	1.2.840.10008.5.1.4.1.2.2.1	1.2.840.10008.1.2	C-FIND
STUDY ROOT Q/R MOVE SCU	1.2.840.10008.5.1.4.1.2.2.2	1.2.840.10008.1.2	C-MOVE
VERIFICATION SCU	1.2.840.10008.1.1	1.2.840.10008.1.2	C-ECHO
Standard Storage SCP (receiving retrieved objects)	<p><i>See "Standard Storage" section of "As Storage SCP" table in "Quick Summary".</i></p>		<p>C-STORE SCP receiving DICOM objects that are retrieved.</p> <ul style="list-style-type: none"> Extended negotiations are not supported. No enforced limit on number of associations. Only TCP/IP protocol is supported. Any physical media supporting the TCP/IP protocol is supported. AE Title, host (or IP address) and port are configurable. Extended character sets are not supported Implementation UID is 1.2.124.113532.1.1, Implementation Version is "FujiDicomSCU"; max. PDU size is 65000.
<u>Fuji Private CR Storage</u>	1.2.392.200036.9125.1.1.2 (Fuji Private CR)	1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2 1.2.840.10008.1.2.4.70	

3. Storing Studies



A modality will use CSTORE service to store images into Synapse.

3.1 Ideal Store scenario

1. Study is ordered in RIS, which assigns a unique identifier to the study. In DICOM terms this unique ID is called the accession number.
2. The modality requests a modality worklist from the DICOM SCP, which provides a list of studies to be performed. The list contains all the pertinent study and patient data such that the data does not need to be entered again at the modality. The accession number as well as the study instance UID is also provided to the modality.
3. The modality generates the study and populates the DICOM headers of the images with the correct accession number, study instance UID and patient demographics. The modality also creates a unique series, and SOP instance UIDs as required by the DICOM standard. If a study consists of images from different modalities, each modality will generate a different study instance UID for the same study, and then it is only the accession number that will indicate if images from different modalities are to be placed in the same study.
4. The modality sends images to the DICOM SCP using C-STORE operations.
5. The modality verifies that the images have been stored via the Storage commitment service class so that it can delete the images from its own local storage.
6. The modality indicates that the procedure has been performed via the performed procedure step service class.

3.2 Non-ideal scenarios

Not all modalities support Modality Worklist, performed procedure step, or Storage Commitment. Due to lack of full DICOM support at the modalities several conditions arise:

- If the modality does not support Modality worklist and only allows patient demographics to be entered manually or via a barcode scan, a DICOM SCP has to use other means to determine to which study the image belongs. This is true even if the modality allows manual entry of a medical record number or accession number, but it does not insert it in the DICOM header.
- If the modality has no Modality Worklist support but allows entry of the accession number and inserts it into the DICOM header, the primary concern is that the accession number may be typed incorrectly and consequently the images could be associated with the wrong study.
- If the modality does not indicate that the procedure has been completed (i.e. no support for Performed Procedure Step), then the DICOM SCP has no way to know that all images of a study have been sent. Unless some mechanism is built in the SCP, a PACS system database would potentially wait forever to determine if all images of a study are available. This may adversely affect the way a PACS system determines when

studies should be available to a Radiologist for reading. Under such circumstances, Synapse Dicom Server assumes that when the C-STORE association is closed, it signals the completion of the transmission of a study.

3.2.1 Accession number

If a modality is unable to provide the accession number in the DICOM headers, the Synapse DicomServer attempts to match the incoming study with a pre-ordered study. If it cannot find a match, a new study is created in the Synapse system as a place to hold the images. If Synapse is able to find the patient, it creates the study for that patient. If Synapse is not able to find the patient then it creates a new patient and stores the study. The creation of a new patient in Synapse is not related to creation of a patient in RIS in this case.

The Fuji Synapse DICOM server uses patient name, ID, gender, date, to “best fit” the image to a study. However, this method does not guarantee 100% success rate.

3.2.2 No indication of completion

If an SCU does not support MPPS, the DicomServer can be configured to consider end of C-STORE association as the completion of transmission of the study.

3.3 C-STORE

The DicomServer generates a “Refused: Out of resources” response if it cannot write the image to a disk or if it cannot update the Synapse database.

The DicomServer generates a “Cannot Understand” response if the image does not contain Study Instance UID. The following table lists the elements in the DICOM header used to display images. See comments for each element.

Attribute	Tag	Comments
Patient name	(0010,0010)	Not required but recommended if Accession number is not present
Patient ID	(0010,0020)	Not required but recommended if Accession number is not present
Accession number	(0008,0050)	Recommended to be present
Study Instance UID	(0020,000D)	Must be present
Modality	(0008,0060)	Must be present
Window Width	(0028,1051)	If not present, an internal algorithm is used
Window Level/Center	(0028,1050)	If not present, an internal algorithm is used
Bits allocated	(0028,0100)	Must be present and must be less than or equal to 16
Bits Stored	(0028,0101)	Must be present
High bit	(0028,0102)	Must be present
Rows	(0028,0010)	Must be present
Columns	(0028,0011)	Must be present
SOP Instance UID	(0008,0018)	Must be present

3.4 Modality Worklist

For all supported matching keys and return values see the Appendix A.

3.5 Storage commitment

Storage commitment Request – Action Information

Attribute	Tag
Transaction UID	(0008,1195)
Reference SOP Seq	(0008,1199)
>Referenced SOP Class UID	(0008,1150)
>Referenced SOP Instance UID	(0008,1155)

- The SCP deletes SOP instances only when there is no space for new images. In that case, the images will be deleted only if the System is configured to do so. New images are refused if there is no space for new images and deletion is not explicitly enabled.
- All images are committed to disk during the CSTORE operations.
- Application Profiles, Storage Media File-Set ID and UID attributes are not supported.

Storage commitment Result – Report, No failures

Attribute	Tag
Transaction UID	(0008,1195)
Reference SOP Seq	(0008,1199)
>Referenced SOP Class UID	(0008,1150)
>Referenced SOP Instance UID	(0008,1155)

Storage commitment Result – Report, Failures

Attribute	Tag
Transaction UID	(0008,1195)
Reference SOP Seq	(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)
>Reference SOP Instance UID	(0008,1155)
>Failure reason	(0008,1197)

- N-EVENT-REPORT is generated in response to the storage commitment request, as specified in the DICOM standard. Upon receipt of the storage commitment request, the SCP will check the Synapse database for the specified SOP instances and generate the result response
- Storage Media file-set ID & UID attributes are not supported
- Application profiles are not supported
- The Retrieve AE title is not supported. An SCU must explicitly use the supported Query/Retrieve models to retrieve such information
- N-EVENT-REPORT will be sent immediately after receiving the N-ACTION message on a separate association but BEFORE the response to N-ACTION is sent. SCUs must be able to handle the request for a separate association.

3.6 Performed procedure step

N-CREATE required attributes

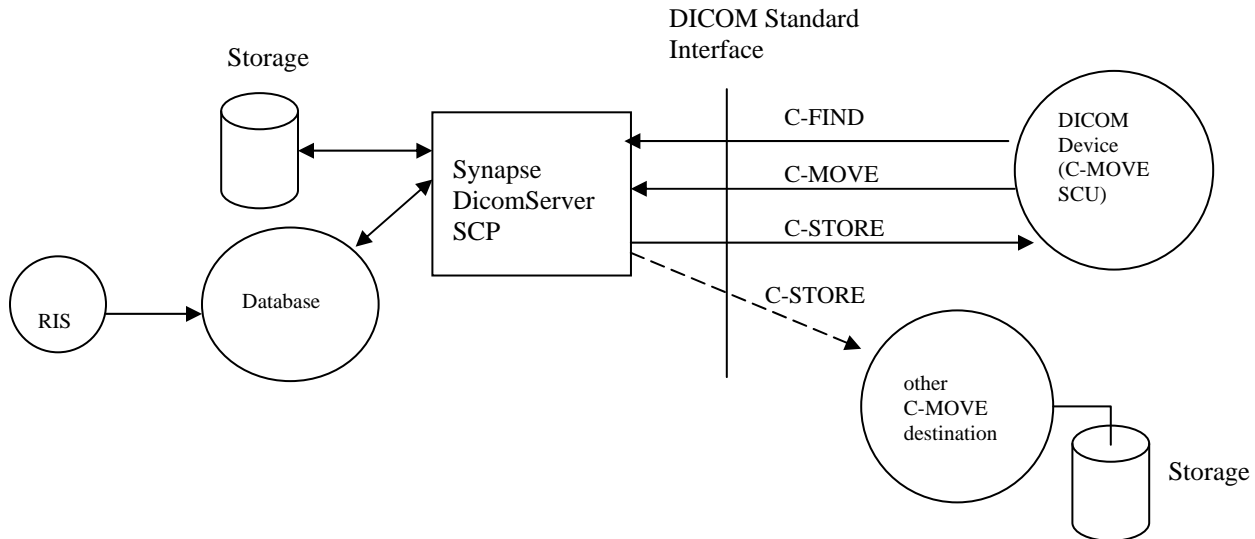
Attribute	Tag
Scheduled Step attribute Sequence	(0040,0270)
>Study Instance UID	(0020,000D)
Performed procedure step ID	(0040,0253)
Performed station AE Title	(0040,0241)
Start date	(0040,0244)
Start time	(0040,0245)
Status	(0040,0252) Must be "IN PROGRESS"
Modality	(0008,0060)

N-SET supported attributes, items in italics must be supplied to properly execute N-SET

Attribute	Tag
<i>Scheduled Step attribute Sequence</i>	<i>(0040,0270)</i>
<i>>Study Instance UID</i>	<i>(0020,000D)</i>
<i>Performed procedure step ID</i>	<i>(0040,0253)</i>
Status	(0040,0252) No changes after COMPLETED or DISCONTINUED

4. Retrieving Studies

Any DICOM-compliant device can retrieve studies from Synapse via the supported Query/Retrieve SOP classes.



The Synapse DicomServer supports the following two Q/R service classes

- Patient Root (C-FIND, C-MOVE)
- Study Root (C-FIND, C-MOVE)

Relational queries are not supported.

4.1 C-FIND

Supported levels

Q/R model	Supported query levels	Operation
Patient Root	Patient, Study, Series, Image	Unique keys for higher levels are required for lower level queries
Study Root	Study, Series, Image	Unique keys for higher levels are required for lower level queries

- As specified in the DICOM standard, in order to retrieve information at lower levels, unique keys for higher levels must be specified. These unique keys for the levels higher than the query level can be obtained by first performing a C-FIND at that same query level. For example, Patient, Study and Series C-FIND operations must be performed to obtain the unique keys for an Image level query in the Patient Root model.

For all supported matching keys and return values see the Appendix A.

The following matching criteria are supported:

- Wildcard matching (* or ?) for the level of the query (except for date and time)
- Range matching (for dates and time)
- Universal matching (data is returned but not used in match)
- UID list matching

4.2 C-MOVE and C-GET

The Synapse DicomServer supports the following C-MOVE models as specified by the DICOM standard.

Supported levels

Q/R model	Supported retrieve levels	Operation
Patient Root (C-MOVE only)	Patient, Study, Series, Image	Unique keys for higher levels are required for lower level queries
Study Root	Study, Series, Image	Unique keys for higher levels are required for lower level queries
Composite Instance Root	Image, Frame	
Composite Instance Root Without Bulk Data (C-GET only)	Image	

For all supported matching keys and return values see the Appendix A.

4.2.1 Matching Attributes

In contrast to the case of C-FIND, only the unique attributes are matched against in a C-MOVE query, i.e.

Patient Level Attributes

Attribute	Tag
Patient ID	(0010,0020) - Unique

Study Level Attributes

Attribute	Tag
Study Instance UID	(0020,000D) - Unique

Series Level Attributes

Attribute	Tag
Series Instance UID	(0020,000E)- Unique

Image Level Attributes

Attribute	Tag
SOP Instance UID	(0008,0018) - Unique

Frame Level Attributes (Only one at a time.)

Attribute	Tag
Simple Frame List	(0008,1161)
Calculated Frame List	(0008,1162)
Time Range	(0008,1163)

The matching criteria are more restrictive than they are in the case with C-FIND. At all levels above the retrieve level, only single value matching is allowed. At the retrieve level, only single value and list-of-UID matching are allowed. For example, if a patient-root retrieve is requested with a retrieve level of 'series', the SCU must supply single values for the patient ID and Study Instance UID, but could supply either a single or a list of series instance UIDs.

In case of C-MOVE, the actual transmission of the matched results takes place on a separate C-STORE association between the Synapse DicomServer and the move destination (which is not necessarily the C-MOVE SCU) and it is done one image at a time. In negotiating the C-STORE association with the C-MOVE destination, JPEG Lossless, JPEG Lossy, little endian explicit and little endian implicit transfer syntaxes are attempted to be negotiated. If the stored image is compressed and its transfer syntax is negotiated, then this transfer syntax will be used for transfer, otherwise little endian explicit transfer syntax is attempted first and then little endian implicit.

A pending status response is sent to the SCU every 60 seconds while images are being transmitted. A final response will be issued when the entire operation has completed. In every C-MOVE response, the number of completed sub-operations and number of failed sub-operations are indicated, with a data set containing the list of failed SOP Instance UIDs if appropriate. The number of remaining sub-operations and the number of warning sub-operations are absent as we do not keep track of those figures.

Synapse DicomServer does not handle the C-MOVE-CANCEL indication. Once the C-MOVE operation has started, it will continue until completion.

5. DICOM Print SCU

The Synapse system includes standard printer drivers to provide an interface to various DICOM printers. The Dicom Print SCU is part of the Synapse Workstation.

5.1 Overview

A Synapse Workstation formats one or more images on a page to be printed. The Workstation sends each page to the DICOM printer as a basic 8-bit grayscale image box. An association is created for each print job and closed at the completion of the job. Print jobs are queued so each printer has one active association open at a time. Windows operating system allows multiple printers to be active, so there is no fixed maximum number of associations.

5.2 Required SOP Classes

The print driver uses the Basic Grayscale Print Management Meta SOP Class.

SOP Class Name	Class UID	Service Group
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	
Basic Film Session SOP Class	1.2.840.10008.5.1.1.1	N-CREATE, N-DELETE
Basic Film Box SOP Class	1.2.840.10008.5.1.1.2	N-CREATE, N-DELETE, N-ACTION
Basic Grayscale Image Box SOP Class	1.2.840.10008.5.1.1.4	N-SET
Printer SOP Class	1.2.840.10008.5.1.1.16	N-GET
Optional:		
Print Job SOP Class	1.2.840.10008.5.1.1.14	N-GET

5.3 Optional SOP Classes

The Print Job SOP Class (1.2.840.10008.5.1.1.14) is optional. If supported it is used to monitor completion of the print job through the N_GET Service Group.

5.4 Supported DICOM Attributes

The SCU can support the following attributes. Individual printer drivers may support a subset of these options.

Attribute	Tag	Supported Options
Copies	(2000,0010)	
Priority	(2000,0020)	HIGH, MED, LOW
Medium Type	(2000,0030)	PAPER, CLEAR FILM, BLUE FILM
Film Destination	(2000,0040)	MAGAZINE, PROCESSOR, BIN_i
Film Session Label	(2000,0050)	
Image Display Format	(2010,0010)	STANDARD\1,1
Film Orientation	(2010,0040)	PORTRAIT, LANDSCAPE
Film Size	(2010,0050)	Display
		8INX10IN, 10INX12IN, 10INX14IN,
		11INX14IN, 14INX14IN, 14INX17IN
		24CMX24CM, 24CMX30CM
Magnification Type	(2010,0060)	REPLICATE, BILINEAR, CUBIC, NONE
Smoothing Type	(2010,0080)	SHARP, SMOOTH, MEDIUM
Border Density	(2010,0100)	BLACK, WHITE, 0-300
Empty Image Density	(2010,0110)	BLACK, WHITE, 0-300
Min Density	(2010,0120)	0-300
Max Density	(2010,0130)	0-300

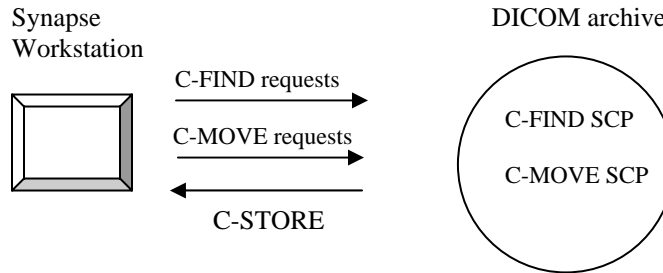
Trim	(2010,0140)	YES, NO
Polarity	(2020,0020)	NORMAL, REVERSE
Bits stored	(0028,0101)	8
Bits allocated	(0028,0100)	8
Printer configuration table	(2010,0150)	CS000-CS999
Printer Status	(2110,0010)	NORMAL, WARNING, FAILURE
Printer Status Info	(2110,0020)	
Execution Status	(2100,0020)	PENDING, PRINTING, DONE, FAILURE

6. DICOM Query/Retrieve SCU

The Synapse system includes the capability of querying/retrieving DICOM images to be viewed at the Synapse Workstation. In DICOM parlance, the Synapse Workstation can act as a DICOM C-FIND and C-MOVE SCU.

6.1 Overview

The basic interactions are depicted in the following diagram



The Synapse Workstation issues DICOM C-FIND and C-MOVE requests. The DICOM archive responds to the requests, and sends the requested items via DICOM C-STORE (on a separate association). In this sense, the Workstation is both a SCU (for C-FIND and C-MOVE) and a SCP (for C-STORE). The Workstation can have (but does not have to have) two distinct DICOM AE titles for these two roles. There is a configurable C-MOVE timeout with a factory default value of 60 seconds.

6.2 Supported SOP Classes

SOP Class Name	Class UID	Service Group
STUDY ROOT Q/R FIND	1.2.840.10008.5.1.4.1.2.2.1	C-FIND SCU
STUDY ROOT Q/R MOVE	1.2.840.10008.5.1.4.1.2.2.2	C-MOVE SCU
VERIFICATION	1.2.840.10008.1.1	C-ECHO SCU
Standard Storage	See "Standard Storage" section of "As Storage SCP" table in "Quick Summary".	C-STORE SCP
<u>Fuji Private CR Storage</u> 1.2.840.10008.1.2 1.2.840.10008.1.2.1 1.2.840.10008.1.2.2 1.2.840.10008.1.2.4.70	1.2.392.200036.9125.1.1.2 (Fuji Private CR)	C-STORE SCP

6.3 Supported DICOM Attributes during C-FIND and C-MOVE

	Query Level	Attribute Name	DICOM Tag	Match/Return
C-FIND	All	SOP Class UID	0002,0002	-
		Query/Retrieve Level	0008,0052	-
	Study	Patient Name	0010,0010	M, R
		Patient ID	0010,0020	M, R
		Study Date	0008,0020	M, R
		Study Time	0008,0030	R
		Accession Number	0008,0050	M, R
		Study ID	0020,0010	R
		Study Instance UID	0020,000D	R

	Series	Modality in Study	0008,0061	R
		Modality	0008,0060	R
		Series Number	0020,0011	R
		Series Instance UID	0020,000E	M, R
	Instance	Instance Number	0020,0013	R
		SOP Instance UID	0008,0018	M, R
		Rows	0028,0010	R
		Columns	0028,0011	R
		Number of Frames	0028,0008	R
		SOP Class UID	0008,0016	R
C-MOVE	Instance	SOP Class UID	0002,0002	-
		Query/Retrieve Level	0008,0052	-
		Destination AE Title	0000,0600	-
		Patient ID	0010,0020	M
		Study Instance UID	0020,000D	M
		Series Instance UID	0020,000E	M
		SOP Instance UID	0008,0018	M

7. DICOM C-STORE SCU

Synapse includes the capability of forwarding DICOM objects to a DICOM C-STORE SCP. When forwarding, Synapse acts as a DICOM C-STORE SCU.

7.1 Overview

The basic interactions are depicted in the following diagram



7.2 Supported SOP Classes

SOP Class Name	Class UID	Service Group
Standard Storage	1.2.392.200036.9125.1.1.2 (Fuji Private CR)	C-STORE SCU
	1.2.840.10008.5.1.1.29 (HGI)	
	1.2.840.10008.5.1.1.30 (HCI)	
<u>Proposed Transfer Syntaxes:</u>	1.2.840.10008.5.1.4.1.1.1 (CR)	
	1.2.840.10008.5.1.4.1.1.1.1 (DX-Prs)	
	1.2.840.10008.5.1.4.1.1.1.1.1 (DX-Proc)	
1.2.840.10008.1.2	1.2.840.10008.5.1.4.1.1.1.2 (MG-Prs)	
1.2.840.10008.1.2.1	1.2.840.10008.5.1.4.1.1.1.2.1 (MG-Proc)	
1.2.840.10008.1.2.4.70	1.2.840.10008.5.1.4.1.1.1.3 (IO-Prs)	
Additionally:	1.2.840.10008.5.1.4.1.1.1.3.1 (IO-Proc)	
1.2.840.10008.1.2.4.50	1.2.840.10008.5.1.4.1.1.2 (CT)	
for HCI, retUS-MF, US-MF, retUS, US, MR, SC, SC-MF-Byte, SC-MF-Word, SC-MF-Color, retNM, NM-MF, XA, RF, VL, ES, GM, SM, XC, ESMF.	1.2.840.10008.5.1.4.1.1.3 (retUS-MF)	
	1.2.840.10008.5.1.4.1.1.3.1 (US-MF)	
	1.2.840.10008.5.1.4.1.1.4 (MR)	
	1.2.840.10008.5.1.4.1.1.4.2 (MRS)	
	1.2.840.10008.5.1.4.1.1.5 (retNM)	
	1.2.840.10008.5.1.4.1.1.6 (retUS)	
	1.2.840.10008.5.1.4.1.1.6.1 (US)	
	1.2.840.10008.5.1.4.1.1.7 (SC)	
	1.2.840.10008.5.1.4.1.1.7.1 (SC-MF-SB)	
	1.2.840.10008.5.1.4.1.1.7.2 (SC-MF-Byte)	
	1.2.840.10008.5.1.4.1.1.7.3 (SC-MF-Word)	
	1.2.840.10008.5.1.4.1.1.7.4 (SC-MF-Color)	
	1.2.840.10008.5.1.4.1.1.8 (STD OVLY)	
	1.2.840.10008.5.1.4.1.1.9 (STD CRV)	
Only:	1.2.840.10008.5.1.4.1.1.10 (MOD LUT)	
1.2.840.10008.1.2	1.2.840.10008.5.1.4.1.1.11 (VOI LUT)	
1.2.840.10008.1.2.1	1.2.840.10008.5.1.4.1.1.12.1 (XA)	
for STD OVLY, STD CRV, MOD LUT, VOI LUT, MRS, SC-MF-SB, ESV.	1.2.840.10008.5.1.4.1.1.12.2 (RF)	
	1.2.840.10008.5.1.4.1.1.12.3 (RF-BP)	
	1.2.840.10008.5.1.4.1.1.13.1.3 (MGT)	
	1.2.840.10008.5.1.4.1.1.20 (NM-MF)	
	1.2.840.10008.5.1.4.1.1.77.1 (VL)	
	1.2.840.10008.5.1.4.1.1.77.1.1 (ES)	
	1.2.840.10008.5.1.4.1.1.77.1.1.1 (ESV)	
	1.2.840.10008.5.1.4.1.1.77.1.2 (GM)	
	1.2.840.10008.5.1.4.1.1.77.1.3 (SM)	

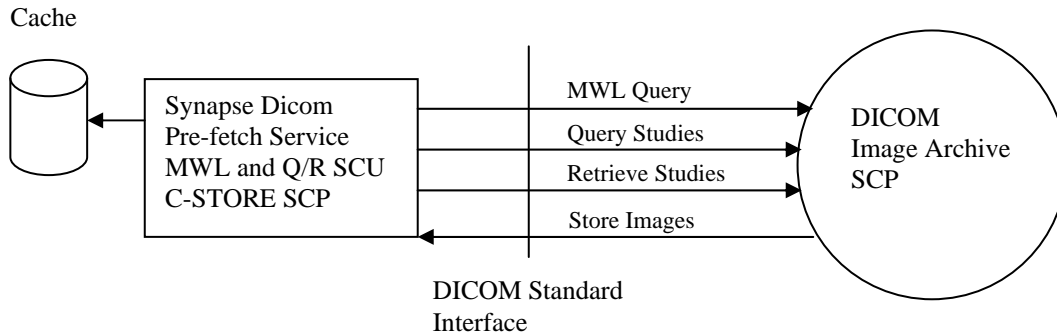
SOP Class Name	Class UID	Service Group
	1.2.840.10008.5.1.4.1.1.77.1.4 (XC) 1.2.840.10008.5.1.4.1.1.77.2 (ESMF) 1.2.840.10008.5.1.4.1.1.128 (PET) 1.2.840.10008.5.1.4.1.1.481.1 (RTIMAGE)	
Standard Storage <u>Proposed Transfer Syntaxes:</u> 1.2.840.10008.1.2 1.2.840.10008.1.2.1	1.2.840.10008.5.1.1.27 (SP) 1.2.840.10008.5.1.4.1.1.9.1.1 (12LECG) 1.2.840.10008.5.1.4.1.1.9.1.2 (GECG) 1.2.840.10008.5.1.4.1.1.9.1.3 (AECG) 1.2.840.10008.5.1.4.1.1.9.2.1 (HD) 1.2.840.10008.5.1.4.1.1.9.3.1 (EPS) 1.2.840.10008.5.1.4.1.1.9.4.1 (AU) 1.2.840.10008.5.1.4.1.1.11.1 (GSPPS) 1.2.840.10008.5.1.4.1.1.11.2 (CSPPS) 1.2.840.10008.5.1.4.1.1.11.3 (PCSPS) 1.2.840.10008.5.1.4.1.1.11.4 (BSPS) 1.2.840.10008.5.1.4.1.1.66 (RAW) 1.2.840.10008.5.1.4.1.1.88.11 (SR Basic Text) 1.2.840.10008.5.1.4.1.1.88.22 (SR Enhanced) 1.2.840.10008.5.1.4.1.1.88.33 (SR Comprehensive) 1.2.840.10008.5.1.4.1.1.88.50 (MG CAD SR) 1.2.840.10008.5.1.4.1.1.88.59 (KOS Document) 1.2.840.10008.5.1.4.1.1.88.65 (CCADSR) 1.2.840.10008.5.1.4.1.1.88.67 (DOESR) 1.2.840.10008.5.1.4.1.1.104.1 (PDF) 1.2.840.10008.5.1.4.1.1.129 (SPTCV) 1.2.840.10008.5.1.4.1.1.481.2 (RTDOSE) 1.2.840.10008.5.1.4.1.1.481.3 (RTSTRUCT) 1.2.840.10008.5.1.4.1.1.481.4 (RTBEAMS) 1.2.840.10008.5.1.4.1.1.481.5 (RTPLAN) 1.2.840.10008.5.1.4.1.1.481.6 (RTBRACHY) 1.2.840.10008.5.1.4.1.1.481.7 (RTSUMMARY) 1.2.840.10008.5.1.4.1.1.481.8 (RTION) 1.2.840.10008.5.1.4.1.1.481.9 (RTIONBEAMS)	C-STORE SCU

8. Pre-fetching Studies

Synapse includes the capability to load images from a Query/Retrieve SCP such as a third-party PACS in advance of a patient’s visit. In order to accomplish this, Synapse will act as a Modality Worklist and Query/Retrieve SCU.

8.1 Overview

Modality Worklist C-FIND queries will be performed, with Synapse acting as the SCU, to determine which patients will be visiting in the near future. This will be followed by additional query and retrieve requests to acquire all of the studies for a patient and load them into a cache prior to the patient’s arrival.



8.2 Supported SOP Classes

SOP Class Name	Class UID	Service Group
MODALITY WORKLIST	1.2.840.10008.5.1.4.31	C-FIND SCU
STUDY ROOT Q/R FIND	1.2.840.10008.5.1.4.1.2.2.1	C-FIND SCU
STUDY ROOT Q/R MOVE	1.2.840.10008.5.1.4.1.2.2.2	C-MOVE SCU
VERIFICATION	1.2.840.10008.1.1	C-ECHO SCU
Standard Storage	See “Standard Storage” section of “As Storage SCP” table in “Quick Summary”.	C-STORE SCP
<u>Fuji Private CR Storage</u>	1.2.392.200036.9125.1.1.2 (Fuji Private CR)	C-STORE SCP
1.2.840.10008.1.2		
1.2.840.10008.1.2.1		
1.2.840.10008.1.2.2		
1.2.840.10008.1.2.4.70		

9. Media Management

Synapse Workstation includes the capability to create DICOM file-sets on CD-R media.

9.1 Overview

The file-sets are generated in accordance with DICOM Part 10 through the use of the Application Profile “STD-GEN-CD” which is described as “General Purpose CD-R Image Interchange”. Synapse Workstation will act as an FSC (File-set Creator) when creating the file-set through the Real World Activity of “Write image(s) on CD-R disk”. Multi-session writing is not supported. Joliet extensions will be written in addition to the ISO 9660 extensions. The Implementation Class UID is: 1.2.840.113845.1.1.

9.2 Supported SOP Classes

The supported SOP Classes are the same as those supported for C-STORE SCU.

10. WADO

Synapse provides access to DICOM images (as well as non-image objects) via WEB technology as stipulated in DICOM standard: “Part 18 -- Web Access to DICOM Persistent Objects (WADO).”

10.1 Overview

WADO requests will be performed, with Synapse acting as the WADO SCP. Persisted DICOM objects will be returned to the user agent as JPEG image, DICOM Part 10 file, plain text, html formatted text or, XML document.

The character set utilized in the response is the one used in storage of such object.

HTTP error code 406 will be issued when request cannot be successfully completed.

10.2 URL Query Parameters

The query parameters handling is as follows:

Table A. WADO URI Request Query Parameters Handling

URL Query Parameter	Name	If Present	If Absent	Requirement
requestType	Request Type must equal “WADO”	OK	406	Required
studyUID	Unique identifier of the study	OK	406	Required
seriesUID	Unique identifier of the series	OK	406	Required
objectUID	Unique identifier of the object	OK	406	Required
contentType	See WADO Request Query Parameter "contentType" Allowable Values table.	OK	Default	Optional
charset		Ignored	OK	Not Supported
anonymize	Anonymize object (if “yes”)	OK	OK	Optional
annotation		Ignored	OK	Not Supported
rows	Number of pixel rows	OK	OK	Optional
columns	Number of pixel columns	OK	OK	Optional
region		Ignored	OK	Not Supported
windowCenter	Window center of the image	OK	OK	Optional
windowWidth	Window width of the image	OK	OK	Optional
frameNumber	Frame number	OK	OK	Optional
imageQuality	Image quality	OK	OK	Optional
presentationUID		Ignored	OK	Not Supported
presentationSeriesUID		Ignored	OK	Not Supported
transferSyntax	Transfer Syntax UID	OK	OK	Optional

The parameter “contentType” specifies the MIME type of the response and it takes on a value, from a set of available values, dependent on the DICOM object type. In itself, being an optional parameter, each object type has a default value assigned to it.

Table B. WADO Request Query Parameter "contentType" Allowable Values

Single Frame Image Objects	Multi-Frame Image Objects	Text Objects	Other Objects	Server response MIME type (contentType)	Default
•				image/jpeg	•
•		•		application/dicom	
	•		•	application/dicom	•
		•		text/plain	
		•		text/html	•
		•		text/xml	

For “application/dicom” MIME type requests that do not specify transfer syntax, the return DICOM object will be in “Explicit VR Little Endian” transfer syntax. For other transfer syntaxes, See “Standard Storage” section of “As Storage SCP” table in “Quick Summary”, as not all are applicable for all DICOM objects. And, not all of those transfer syntaxes that are applicable for a given SOP Class are necessarily supported.

10.3 Supported SOP Classes

All the DICOM objects stored via C-STORE can be retrieved via WADO.

11. Security and System Management Profiles

Synapse conforms with parts of DICOM Standard that aim to secure the system.

11.1 Association Level Security

Application Entity Titles can be used to restrict DICOM Associations for C-STORE, Query/Retrieve, MWL Query, Storage Commitment.

11.2 Application Level Security

11.2.1 Security Profiles

No security profiles are supported in current software release.

11.2.2 Audit Trail Messages

See Table C. DICOM Specific Audit Messages.

Table C. DICOM Specific Audit Messages

Message	Message ID	Event
Application Activity	110100	DICOM Server start up and shutdown
DICOM Instance Transferred	110104	C-MOVE, C-GET
Import	110107	C-STORE
Query	110112	C-FIND

Appendix A – Query/Retrieve Attribute Support

COMMAND ROOT LEVEL QUERY LEVEL	MWKL	C-FIND						C-MOVE				C-MOVE & C-GET					
	Study	Patient			Study			Patient				Study			Instance		
	Study	Patient	Study	Series	Image	Study	Series	Image	Patient	Study	Series	Image	Study	Series	Image	Image	Frame
DICOM Tag																	
00080016,UI SOP Class UID					o			o	o	o	o	o	o	o	o	o	o
00080018,UI SOP Instance UID					f,o			f,o				f			f	x	x
00080020,DA Study Date				f,o	o	o	f,o	o	o	o	o	o	o	o	o	o	o
00080030,TM Study Time				f,o	o	o	f,o	o	o	o	o	o	o	o	o	o	o
00080056,CS Instance Availability			o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
00080050,SH Accession Number	f,o		f,o	o	o	f,o	o	o	o	o	o	o	o	o	o	o	o
00080060,CS Modality				f,o	o	f,o	o										
00080061,CS Modalities in Study				f,o	o	f,o	o										
00080080,LO Institution Name				o	o	o	o	o	o								
00080090,PN Referring Physician's Name	o			o		o		o	o	o	o	o	o	o	o	o	o
00081030,LO Study Description				o		o			o	o	o	o	o	o	o	o	o
0008103E,LO Series Description				o		o											
00081032,SQ,1:00080100,SH Procedure Code									o	o	o	o	o	o	o	o	o
00081032,SQ,1:00080102,SH Procedure Designator									o	o	o	o	o	o	o	o	o
00081032,SQ,1:00080104,LO Procedure Description									o	o	o	o	o	o	o	o	o
00081161,LU Simple Frame List																	x ¹
00081162,LU Calculated Frame List																	x ¹
00081163,FD Time Range																	x ¹
00100010,PN Patient's Name	f,o	f,o	o	o	o	f,o	f,o	f,o	o	o	o	o	o	o	o	o	o
00100020,LO Patient ID	f,o	f,o	x,o	x,o	x,o	f,o	f,o	f,o	f,o	x,o	x,o	x,o	f,o	f,o	f,o	o	o
00100030,DA Patient's Birth Date	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
00100040,CS Patient's Sex	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
00102160,SH Ethnic Group			o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
00200010,SH Study ID	f		f,o	o	o	f,o	o	o									
0020000D,UI Study Instance UID	f,o		f,o	x,o	x,o	f,o	x,o	x,o	o	f,o	x,o	x,o	f,o	x,o	x,o	o	o
0020000E,UI Series Instance UID				f,o	x,o	f,o	x,o	o	o	f,o	x,o	o	f,o	x,o	o	o	o
00200011,IS Series Number				f,o	o	f,o	o										
00200013,IS Instance Number					f,o		f,o										
00201206,IS # of Study Related Series				o	o	o	o	o									
00201208,IS # of Study Related Instances				o	o	o	o	o									
00201209,IS # of Series Related Instances				o	o		o	o									
00280008,IS Number of Frames					o		o										
00280010,US Rows					o		o										
00280011,US Columns					o		o										
00321032,PN Requesting Physician	o																
00321033,LO Site ID									o	o	o	o	o	o	o	o	o
00321060,LO Requested Procedure Description	o																
00321064,SQ,1:00080100,SH Requested Procedure Code	o																
00321064,SQ,1:00080102,SH Requested Procedure Designator	o																
00321064,SQ,1:00080104,LO Requested Procedure Description	o																
00380010,LO Admission ID	o																
00400100,SQ,1:00080060,CS Sched Proc Step Modality	f,o																
00400100,SQ,1:00400001,AE Scheduled Station AE Title	o																
00400100,SQ,1:00400002,DA Sched Proc Step Start Date	f,o																
00400100,SQ,1:00400003,TM Sched Proc Step Start Time	f,o																
00400100,SQ,1:00400006,PN Sched Perform Phys Name	o																
00400100,SQ,1:00400007,LO Sched Proc Step Description	o																
00400100,SQ,1:00400009,SH Scheduled Procedure Step ID	o																
00400241,AE Performed Station AE Title			o	o	o		o										

00401001,SH Requested Procedure ID	o																							
00401003,SH Requested Procedure Priority	o																							
0040A043,SQ,1:00080100,SH Concept Name Code Sequence – Code Value											f,o,c													
0040A043,SQ,1:00080102,SH Concept Name Code Sequence – Coding Scheme Designator											f,o,c													
50xx200C,OB OW Audio Sample Data (Retired)																					r	r		
50xx3000,OB OW Curve Data (Retired)																					r	r		
54001010,OB OW Waveform Data																					r	r		
56000020,OF Spectroscopy Data																					r	r		
60xx3000,OB OW Overlay Data																					r	r		
7FE00010,OB OW Pixel Data																					r	r		
All other tags											o,c													

Note: In Instance column, the “Composite Instance Retrieve Without Bulk Data – GET” has only “Image” Retrieve level.

Legend

c: Supported only for the Mammography CAD SR, Grayscale Softcopy Presentation State and Key Object Selection SOP

f: Filter attribute (used in matching)

o: Output attribute

r: returned in case of “Retrieve” but not in case of “Retrieve w/o Bulk Data”

x: Filter attribute required at that level (x¹: only one attribute allowed)