Profiles for the VistA Imaging and Commercial PACS DICOM Interface

Including Business and Functional Requirements

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Foreword

This document contains IHE profiles for all DICOM operations, -- using the corresponding IHE Technical Framework transaction descriptions -- that are necessary for successful interfacing between the VistA Imaging system and a commercial Picture Archiving and Communication Systems (PACS).

VA has been a leader in the development of HIS-RIS-PACS interfaces for over a decade and a half. The currently running VA-PACS interface is based on the 1997 DICOM standard. At the present time, VA is in the process of updating this interface by adding functionality to support HL7 Version 2.4 and the 2008 DICOM standard. The profiles defined in this document will support a new IHE-compliant DICOM interface.

The purpose of this interface specification is to facilitate PACS systems so that they may successfully store and retrieve DICOM objects to and from VistA Imaging. It defines the business and functional requirements for this interface, including some VistA Imaging specific requirements, the various conditions that can occur during operation, and the expected behavior of the PACS under the possible circumstances. It also identifies the VistA Imaging -- and where needed the VistA HIS -- data elements that will be handled by the new interface, as well as the DICOM constructs that contain those data elements.

A detailed knowledge of the DICOM standard is assumed; this document merely extends and clarifies standard DICOM conformance requirements with IHE profile recommendations to ease and assure connectivity and eliminate possible ambiguities in the DICOM specifications.

This document must be used in concert with other VA interface documents titled:
- *Profiles for HL7 messages from VistA to Commercial PACS*, that requires PACS IHE Technical Framework defined conformance on Scheduled Work Flow (SWF) and Patient Information Reconciliation (PIR), and the
- *Joint VA / DoD Requirements for Digital Acquisition Modality Devices* specification that defines DICOM and IHE Technical Framework defined conformance for modality devices. This document gives PACS vendors information on modality device interfaces required by the two agencies.

Organization of this Document

Specifications in this document are organized into IHE Technical Framework Radiology conformance profiles (Rad-xx). Image Available Notification (Rad-49), bidirectional Study Root Query/Retrieve (Rad-11, Rad-14 and Rad16), bidirectional Storage (Rad-8) and Storage Commitment (Rad-10) profiles are covered.

The Introduction to this document contains the Basic DICOM Information Model with workflow scenarios that summarize the DICOM operations between the VistA Imaging

system and a commercial PACS; Mapping DICOM Operations to IHE Radiology Profile Transactions; Basic VistA Imaging Assumptions; VistA Imaging DICOM Characteristics; VistA Imaging Required Storage SOP Classes; and finally, the Approach and Terminology used in this document.

Each chapter after the Introduction contains a complete IHE transaction profile. Each profile covers a DICOM operation that corresponds to a transaction documented in the IHE Radiology Technical Framework (rev 8). Each of these profiles is divided into sections as prescribed by the IHE Technical Framework:

- **Use case**: including scope, actors and roles
- **Interactions**: showing the message(s) sent and expected within the communications portion of the interface; DICOM association-negotiation message exchanges not shown.
- **Dynamic Definition**: contain the business and functional requirements as well as error handling behavior for DICOM operation processing
- **DICOM-Specific Definitions**
  - o **SOP class level**, showing the SOP classes support in Service(s)
  - o **IOD level**, describes VA constraints, DICOM standard and IHE profile interpretation specific facts.
  - o **Element level (optional),** describes Profile- and VistA Imaging-specific expectations in specific DICOM tags.

The structure listed above is derived in part from the conventions used in the discussion of HL7 Conformance Profiles in the *Health Level Seven Standard*, Version 2.5, Section 2.12 altered/extended by DICOM specific definitions.

References

Consolidated Healthcare Informatics (CHI). Standards Adoption Recommendation: Multimedia Information in Patient Records, see http://www.va.gov/imaging/.

DICOM Standard, available at http://medical.nema.org/.

HL7 Standard, available at www.hl7.org.

Integrating the Healthcare Enterprise (IHE) Initiative. IHE Radiology Technical Framework. www.ihe.net, 2007.

Joint VA/DOD DICOM Modality Conformance Requirements, available at www.va.gov/imaging/.

NIST Special Publication 800-53, Recommended Security Controls for Federal Information Systems, NIST Computer Security Division , Gaithersburg, MD, available at www.nist.gov, 2005.

NIST Special Publication 800-53A, Guide for Assessing the Security Controls for Federal Information Systems, NIST Computer Security Division , Gaithersburg, MD, available at www.nist.gov, Draft for Public Comment, August 2007.

Profiles for HL7 Messages from VistA to Commercial PACS including Business and Functional Requirements", v.1.2, available at http://www.va.gov/imaging/.

Definitions

Term	Definition
Abstract Syntax	Same as the SOP (service/object pair) class. A combination of the service class and the type of information object (IOD) upon which it should operate.
ACR-NEMA	American College of Radiology-National Electrical Manufacturers Association
AE	Application Entity
ANSI	American National Standards Institute
Application Context	Associated with transport connection. A single application context is used for all DICOM communication: the DICOM 3.0 application context.
Application Entity	Can be a program, a piece of a program, or a group of programs that cooperate with one another. In an abstract sense, it can be viewed across the network as a single collective entity.
Association	Context for communication.
ACSE	Association control service element; the type of service element used to set up an association.
Attribute	A property of an information object. It has a name and a value that are independent of any encoding scheme.
Big-Endian	A form of byte ordering where multiple byte binary values are encoded with the most significant byte encoded first; and the remaining bytes encoded in decreasing order of significance.
Command	A DICOM command is a generic means to operate on information objects across an interface or network.
Command element	An encoding of a command parameter that conveys the parameter's value.
Commands stream	The result of encoding a set of DICOM command elements using the DICOM encoding scheme.
Composite, C-	A type of information objects that contains multiple attributes of more than one type of Information Entity Modules, opposed to Normalized (N-...) objects that contain only one attribute of a single Information Entity Module type.
Composite Object Instance	A type of information object that contains attributes of more than one type of Information Entity Modules, as opposed to Normalized (N-...) Object Instances that contain only one attribute of a single Information Entity Module type. Earlier versions of the DICOM standard

Term	Definition
	referred to Composite Object Instances as Images, that, by time, became misleading as nowadays Composite Object Instances cover several types of IODs (like Image, Presentation State, Waveform, Raw Data, SR Document, etc. IODs)
Compression	A technique by which the size of a file or image is reduced, while maintaining the quality required for a given application.
Conformance Statement	A formal statement associated with a specific implementation of the DICOM standard. It specifies the service classes, information objects, and communication protocols supported by the implementation.
CR	Computed Radiography
Data Dictionary	A registry of DICOM data elements which assigns a unique tag, a name, value characteristics, and semantics to each data element.
Data Element	A unit of information as defined by a single entry in the data dictionary.
Data Element Tag	A unique identifier for a Data Element composed of an ordered pair of numbers (a Group Number followed by an Element Number).
Data Set	Exchanged information consisting of a structured set of attribute values directly or indirectly related to information objects. The value of each attribute in a data set is expressed as a data element.
Data stream	The result of encoding a Data Set using the DICOM encoding scheme (data element numbers and representations as specified by the data dictionary).
Digital Signature	Authentication attribute as defined in DICOM P3.15.
Digital Signature Levels	DICOM defines 3 levels of Digital Signature for SCPs: *Signature Level 1*. SCP may not preserve Digital Signatures and does not replace them. *Signature Level 2*. SCP does not preserve the integrity of incoming Digital Signatures, but does validate the signatures of SOP Instances being stored, takes implementation-specific measures for insuring the integrity of data stored, and will add replacement Digital Signatures before sending SOP Instances elsewhere. *Signature Level 3*. SCP does preserve the integrity of incoming Digital Signatures (i.e. is bitpreserving and stores and retrieves all Attributes regardless of whether they are defined in the IOD).
DICOM	Digital Imaging and Communications in Medicine (also called ACR-NEMA 3.0)
DIMSE	DICOM message service element. DIMSE-C for

Term	
	Composite elements, DIMSE-N for Normalized.
Element types	1=required 1C=required if a condition is met 2=primary diagnostic; required 2C=primary diagnostic; required if a condition is met 3=optional.
ER	Emergency room
Exam/Study	A collection (set) consisting of series of images.
FD	Film digitizer
FDA	Food and Drug Administration
FSC	File-set Creator
FSR	File-set Reader
HIPAA	Health Information Portability and Accountability Act
HIS	Hospital Information System
HTML	Hypertext Markup Language
IAN	Instance Availability Notification (a consumer profile described in Chapter 1 of this document)
IAQ	Image Availability Query (a provider profile described in Chapter 2 of this document)
IE	Information Entity
IHE	Integrating the Healthcare Environment. The IHE initiative is not to define new integration standards, but rather to support the use of existing standards,-- initially DICOM and HL7, but potentially others, -- as appropriate in their respective domains, in an integrated manner, defining configuration choices when necessary.
IEEE	Institute of Electrical and Electronics Engineering
Image Box	The area of a film in which an image appears.
IO	Intraoral dental image to include periapical or bite-wing dental image.
IOD	Information Object Definition
Information Object Class	A formal description of an information object which includes a description of its purpose and the attributes it possesses. It does not include values for these attributes.
Information Object Instance	A representation of an occurrence of a DICOM Terminology 5 real-world entity, including values for the attributes of the Information Object Class to which the entity belongs. There are Composite and Normalized Object Instances differentiated in DICOM
Information Object	An abstraction of a real information entity (e.g., CT, study, etc.), which is acted upon by one or more DICOM commands.
Little Endian	A form of byte ordering where multiple byte binary values are encoded with the least significant byte encoded first; and the remaining bytes encoded in increasing order of significance.

Term	Definition
LUT	Look-Up Table--A matrix that maps image values from one context into another.
Message	A data unit of the message exchange protocol exchanged between two cooperating DICOM application entities. A message is composed of a command stream followed by an optional data stream.
MIS	Modality Images Stored (profiles described in Chapters 4 and 8 of this document)
Modality	A device that produces medical images
Module	A group of related information object attributes
MRA	Magnetic Resonance Angiography
MR	Magnetic Resonance
NIST	National Institute of Standards and Technology
NM	Nuclear Medicine
Normalized, N-	A type of information object that contains only one attribute, as opposed to a composite object, which can contain many attributes
OID	Object Identifier
OSI	Open System Interconnection
PACS	Picture Archiving and Communication System
Patient Information	The demographic data pertaining to a patient
PDF	Portable Document Format
PDU	Protocol Data Unit
Presentation Context	Contains Abstract and Transfer Syntax pairs; represents capabilities offered by a DICOM AE; Reconciling Presentation Context by two communicating AEs is called the Association-Negotiation process by which both peers of a DICOM communication channel agree what they're going to be doing and how they're going to encode the data.
Presentation Context ID	Unique identifier for a Presentation Context
Print Queue	A group of images waiting to print.
Private Data Element	Additional Data Element, defined by an implementer, to communicate information that is not contained in Standard Data Elements. Private Data elements have odd Group Numbers.
Profile	In IHE terms a well defined set of operations or services to be performed, makes connectivity via standards more straightforward and down to the point.
Protocol	Data format; the format data must be in for peer-to-peer communication.
Protocol data unit	PDU. The block used to encode data that passes over an association.
PDV	Protocol data value.

Term	Definition
PX	Panoramic dental image
QI	Query Images (a consumer profile described in Chapter 6 of this document)
Retired Data Element	A Data Element that is unsupported beginning with Version 3.0 of the DICOM standard. Implementations may continue to support Retired Data Elements for the purpose of backward compatibility with versions prior to V. 3.0, but this is not a requirement.
RI	Retrieve Images (profiles described in Chapters 3 and 7 of this document)
RIS	Radiology Information System.
SC	Storage Commitment (a consumer profile described in Chapter 5 of this document)
SCP	Service Class Provider.
SCU	Service Class User.
SDL	Source density LUT.
Service	Entity that allows layer-to-layer communication
Service Class	A structured description of a service supported by cooperating DICOM Application Entities using specific DICOM commands and acting on various classes of information objects.
Service Class Provider	The sum of the wire plus all of the lower levels (below the application level), as a provider.
Service Class User	The sum of the wire plus all of the lower levels (below the application level), as a user.
Service Object Pair	The combination of a Service Class and the type of Information Object Definition (IOD) upon which this Service Class can operate. (SOP). DICOM Terminology
SOP	Service-Object Pair.
Standard Data Element	A Data Element defined in the DICOM standard, and therefore listed I the DICOM Data Element Dictionary (PS 3.6). See also Private Data Element, Retired Data Element.
TCP/IP	Transmission control protocol/Internet protocol.
Transfer Syntax	How objects should be encoded; can be standard and/or private. A set of encoding rules that allow Application Entities to unambiguously negotiate the encoding techniques (e.g., Data Element structure, byte ordering, compression) they are able to support, thereby allowing these Application Entities to communicate.
Transport connection	A way of moving unstructured data across a network (e.g., TCP/IP socket or stream); a pipeline
UID	DICOM Unique Identifier that unambigiously represents abstract DICOM terms and real world object instances,

Term	Definition
	like Transfer Syntaxes, Abstract Syntaxes, Object Instances, etc.
UUID	Universal Unique Identifier (ISO/IEC 11578)
US	Ultrasound.
VL	Visible Light (color) images
VR	Value Representation. Specifies the data type and format of the value(s) contained in the Value Field of a Data Element.
W3C	World Wide Web Consortium
WADO	Web Access of DICOM Objects
WAN	Wide Area Network.
XC	External Camera with ability to take visible light images

Introduction

0.1 Basic DICOM Information Model – with IHE Profiles
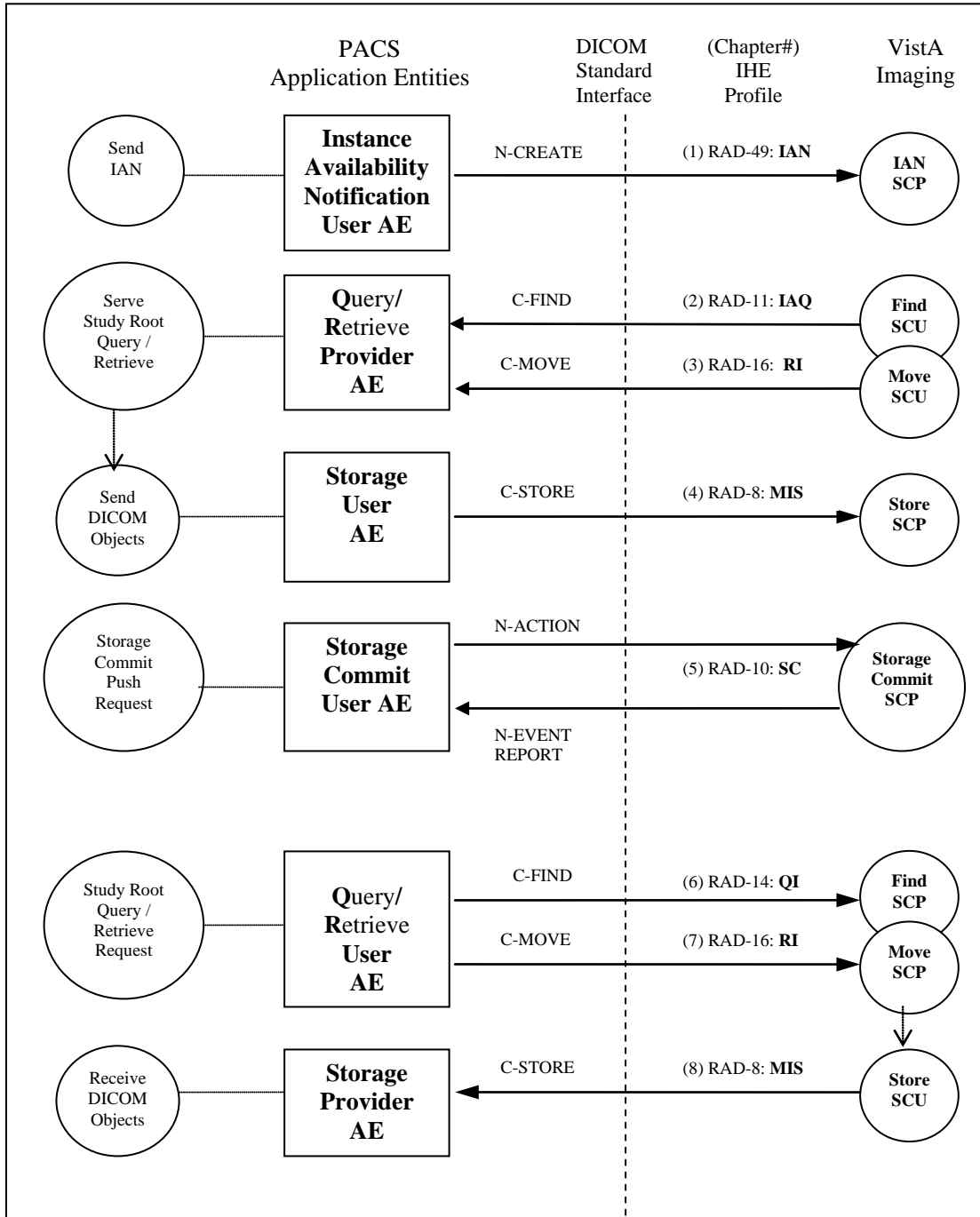
Figure 0-1: VistA Imaging – PACS DICOM Implementation Model with IHE Profiles

Figure 0-1 depicts the eight DICOM operations of the PACS –VistA Imaging Interface using DICOM terminology and also identifying the relevant IHE profiles.

All of these DICOM operations and PACS-side AE title activities (in bold) will be referred to throughout the eight IHE profile-based chapters of this document. The IHE Profile references are also displayed. The arrow crossing the DICOM Interface line always points from a DICOM Service Class User type Application Entity (SCU AE) to a Service Class Provider type Application Entity (SCP AE).

Every PACS **AE** has corresponding PACS Interface Profiles described in Chapter 1 to 8 of this document.

0.1.1 VA PACS Business Requirements

Table 0-1 below states the VA PACS business requirements:

PACS Application Entity	Requirement	Implementation Date
IAN User AE	Mandatory	July 1, 2010
Query/Retrieve Provider AE	Mandatory	Now
Storage User AE	Mandatory	Now
Storage Commit User AE	Optional	July 1, 2010
Query/Retrieve User AE	Optional	Now
Storage Provider AE	Optional	Now
Auto-routing	Optional, but highly desired	Now

Table 0-1: PACS Application Entity Requirements

0.1.2 PACS to VistA Imaging – Archive Workflow

Following is the *basic flow* of the PACS archival process to VistA Imaging:

- The PACS auto-routes DICOM objects to the VistA Imaging **Store SCP** AE.

- The PACS sends IAN (Chapter 1) message(s) to VistA Imaging.

- If needed, VistA Imaging retrieves (Chapter 3) missing Objects from PACS by initiating Store operations from PACS to VistA Imaging (Chapter 4).

- Optionally, the PACS commits (Chapter 5) archived Study Object Instances to VistA Imaging.

In case *no auto-routing* occurred, VistA Imaging relies on IAN messages:

- The PACS sends IAN (Chapter 1) message(s) to VistA Imaging.

- VistA Imaging queries (Chapter 2) PACS for Study, Series and all related Object Instances.

- VistA Imaging retrieves (Chapter 3) missing Objects from PACS by initiating Store operations from PACS to VistA Imaging (Chapter 4).

In case *no IAN messages* received, but auto-routing is supported:

- The PACS auto-routes DICOM objects to the VistA Imaging **Store SCP** AE.

- VistA Imaging queries (Chapter 2) PACS for Study, Series and all related Object Instances.

- If needed, VistA Imaging retrieves (Chapter 3) missing Objects from PACS by initiating Store operations from PACS to VistA Imaging (Chapter 4).

- Optionally, the PACS commits (Chapter 5) Archived Study Object Instances to VistA Imaging.

In case *no auto-routing* occurred *and no IAN messages* are received, VistA Imaging learns about the Study Acquisition Completed event from the VistA (RIS) HL7 message "Exam Verified". In this scenario the workflow is as follows:

- VistA Imaging receives VistA (RIS) trigger event about Study Acquisition Complete.

- VistA Imaging queries (Chapter 2) PACS for Study, Series and all related Object Instances.

- VistA Imaging retrieves (Chapter 3) missing Objects from PACS by initiating Store operations from PACS to VistA Imaging (Chapter 4).

0.1.3 PACS Study Retrieval from VistA Imaging

When the PACS needs earlier archived Study Objects, it retrieves them from VistA Imaging as follows:

- Optionally, the PACS queries (Chapter 6) VistA Imaging for Study, Series and all related Object Instances.

- PACS retrieves (Chapter 7) needed Objects from VistA Imaging by initiating Store operations from VistA Imaging to PACS (Chapter 8).

0.2 Mapping DICOM Operations to IHE Profile Transactions

Table 0-2 assigns IHE Technical Framework Radiology transactions to the VistA Imaging – PACS DICOM Interface basic operation:

DICOM Operation	IHE Profile	PACS IHE Actor	VistA Imaging IHE Actor	IHE Transaction
Instance Availability Notification (IAN) – from PACS to VI	Instance Availability Notification **IAN**	Image Manager / Image Archive **SCU**	Post-Processing Manager **SCP**	**Rad-49**
Query (Q/R) – from VI to PACS	Image Availability Query **IAQ**	Image Manager **SCP**	DSS/Order Filler **SCU**	**Rad-11**
– from PACS to VI	Query Images **QI**	Image Display **SCU**	Image Archive **SCP**	**Rad-14**
Retrieve (Q/R) – from PACS to VI	Retrieve Images **RI**	Image Archive **SCP**	Image Display **SCU**	**Rad-16**
– from VI to PACS		Image Display **SCU**	Image Archive **SCP**	
Storage (Store) – from PACS to VI	Modality Images Stored **MIS**	Acquisition Modality **SCU**	Image Archive **SCP**	**Rad-8**
– from VI to PACS		Image Archive **SCP**	Acquisition Modality **SCU**	
Storage Commitment (SC) -- from PACS to VI	Storage Commitment **SC**	Evidence Creator **SCU**	Image Manager **SCP**	**Rad-10**

Table 0-2: Mapping DICOM Operations to IHE Profile Transactions

0.3 Basic Assumptions

A number of basic assumptions guide the VistA Imaging – PACS DICOM interface's business and technical requirements. The VA is responsible for its patient data, and its systems must comply with a number of external and internal regulations including the Federal Privacy Act, the FDA, and HIPAA. The VA Office of Information issues requirements to protect its internal and external interfaces. Some of these basic interface requirements are listed below and are described in detail in the *Profiles for HL7 Messages from VistA to Commercial PACS*.

- VistA is the system of record of patient information. All additions, deletions, and corrections to patient data must be performed on VistA first and then performed on the PACS in response to messages from VistA Imaging.

- Every patient will be able to be identified using two separate values, both an internal and external patient identifier. These identifiers will be passed to interfaced commercial PACSs.

  o The Integration Control Number (ICN) is the internal patient identifier. This is a VA-wide unique value that is assigned to each patient and shall be used by various systems to identify the patient. There is a 1:1 correspondence between patients and ICNs. If the patient is seen at multiple sites, the same ICN value will be used at each site.

  o The external patient identifier is the Social Security Number (SSN), and is used by staff personnel to access the patient's record. (SSNs are known not to be unique – duplicates exist.)

  o The PACS shall maintain indices to both the internal and external patient identifiers in its database.

  o Access to sensitive (VIP) patient information shall be restricted according to individual VHA and Federal requirements (i.e. The Privacy Act of 1974).

- Event data on VistA shall be communicated to the PACS using HL7.

  o Every HL7 transaction sent from VistA to PACS will contain the full set of patient identification information, including both the internal and external patient identifiers (that is, the ICN and the SSN).

  o The PACS shall use the ICN to provide positive identification of the patient and associate each incoming HL7 transaction with the information in its database.

- The VistA Radiology Package, which functions as the radiology information system (RIS), is the system of record for all radiology order and report information. Radiology orders and reports are entered into the VistA RIS and are then sent to the PACS. All additions, deletions, corrections to this data must be made on VistA first and then conveyed to the PACS.

0.4 Common VistA Imaging DICOM Characteristics

a) DICOM objects acquired by the PACS shall be stored to VistA Imaging for long-term archiving (as specified by VHA Directives).

b) VistA Imaging is a DICOM Level 2 (full) storage SCP with Digital Signature Level 1 support[1]. Note: VistA Imaging, as the system of record, might update patient- and study-related information if needed, but will never remove DICOM tags and values.

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[1] In spite of not using Extended Negotiation the VistA Imaging Store SCP complies with Signature Level 1.

c) According to the DICOM Standard, the vendor shall support Verification SCP for all PACS Application Entities that may accept an association.

d) No extended negotiation is used in any of the VistA Imaging DICOM operations. Reverse Role Negotiation is only supported for Storage Commitment (SC) N-EVENT-REPORT delivery from the VistA Imaging SC SCP to the PACS SC SCU.

e) VistA Imaging does not support asynchronous communication (multiple simultaneous transactions) over a single Association.

f) VistA Imaging does not support JPIP transfer syntax.

g) Unlike in the DICOM E-R Model, VistA Imaging Cardinality between Imaging Service Request (**ISR**) and Requested Procedure (**RP**) is **1:1**.

DICOM E-R Entity	VistA Imaging Term
Patient	Patient
--	"Patient Order"
ISR	"Case"
RP	"Order"
Study	"Case", "Exam", "Study"

Table 0-3: DICOM E-R Model Terms vs. VistA Imaging Terms

In the DICOM E-R Model cardinality for Patient - ISR and ISR - RP is 1:N, and for RP - Study is 1:1. In VistA Imaging terminology an ISR is called a "*Case*" or "*Exam*", an RP is called an "*Order*" and there is a radiology "*Patient Order*" term that has no DICOM E-R Model equivalent, for which cardinality to a *Case is 1:N*. As the VistA Imaging *Case - Order* (ISR - RP) cardinality as well as the DICOM E-R RP - Study cardinality is 1:1, a VistA Imaging Study is also referred to as a *Case or Exam*. In other words a VistA Imaging Accession Number (ISR), opposed to the DICOM model, uniquely identifies an "Order" (RP) as well as a "Study".

h) The VistA Imaging implementation identifying information is:

Implementation Class UID	1.2.840.113754.2.1.3.0
Implementation Version Name	VA DICOM V3.0

Table 0-4: VistA Imaging DICOM Implementation Class and Version

i) The C-GET DIMSE service group is not supported in VistA Imaging Query/Retrieve Information Models.

0.5 VistA Imaging Required Storage SOP Classes

Table 0-5 below represents present and planned VistA Imaging DICOM SOP Class storage capabilities.

All SOP classes support the

Implicit VR Little Endian (1.2.840.10008.1.2) and the

Explicit VR Little Endian (1.2.840.10008.1.2.1) Transfer Syntaxes.

The SOP classes marked with * also support the

JPEG Lossy Baseline (1.2.840.10008.1.2.4.50) ,

JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1]) (1.2.840.10008.1.2.4.70) and the

JPEG Lossless Non-hierarchical /Proc 14/ (1.2.840.10008.1.2.4.57) Transfer Syntaxes.

JPEG 2000 Lossless Image Compression Transfer Syntax (1.2.840.10008.1.2.4.90) will also be supported for all objects that carry image pixel data in tag (70FE,0010).

SOP Class Name	SOP Class UID
Verification SOP Class	1.2.840.10008.1.1
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1
Digital X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.1
Digital X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.1.1
Digital Mammography X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.2
Digital Mammography X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.2.1
Digital Intra-oral X-Ray Image Storage - For Presentation	1.2.840.10008.5.1.4.1.1.1.3
Digital Intra-oral X-Ray Image Storage - For Processing	1.2.840.10008.5.1.4.1.1.1.3.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
Enhanced CT Image Storage	1.2.840.10008.5.1.4.1.1.2.1
Ultrasound Multi-frame Image Storage *	1.2.840.10008.5.1.4.1.1.3.1
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
Enhanced MR Image Storage	1.2.840.10008.5.1.4.1.1.4.1
MR Spectroscopy Storage	1.2.840.10008.5.1.4.1.1.4.2
Nuclear Medicine Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.5
Ultrasound Image Storage (Retired)	1.2.840.10008.5.1.4.1.1.6
Ultrasound Image Storage *	1.2.840.10008.5.1.4.1.1.6.1
Secondary Capture Image Storage *	1.2.840.10008.5.1.4.1.1.7
Multi-frame Single Bit Secondary Capture Image Storage *	1.2.840.10008.5.1.4.1.1.7.1
Multi-frame Grayscale Byte Secondary Capture Image Storage *	1.2.840.10008.5.1.4.1.1.7.2
Multi-frame Grayscale Word Secondary Capture Image Storage *	1.2.840.10008.5.1.4.1.1.7.3
Multi-frame True Color Secondary Capture Image Storage *	1.2.840.10008.5.1.4.1.1.7.4
Twelve Lead ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.1
General ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.2
Ambulatory ECG Waveform Storage	1.2.840.10008.5.1.4.1.1.9.1.3
Hemodynamic Waveform Storage	1.2.840.10008.5.1.4.1.1.9.2.1
Cardiac Electrophysiology Waveform Storage	1.2.840.10008.5.1.4.1.1.9.3.1
Basic Voice Audio Waveform Storage	1.2.840.10008.5.1.4.1.1.9.4.1
Grayscale Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.1
Color Softcopy Presentation State Storage SOP Class	1.2.840.10008.5.1.4.1.1.11.2

SOP Class Name	SOP Class UID
Pseudo-Color Softcopy Presentation State Storage SOP Class	**1.2.840.10008.5.1.4.1.1.11.3**
Blending Softcopy Presentation State Storage SOP Class	**1.2.840.10008.5.1.4.1.1.11.4**
X-Ray Angiographic Image Storage *	**1.2.840.10008.5.1.4.1.1.12.1**
Enhanced XA Image Storage	**1.2.840.10008.5.1.4.1.1.12.1.1**
X-Ray Radiofluoroscopic Image Storage	**1.2.840.10008.5.1.4.1.1.12.2**
Enhanced XRF Image Storage	**1.2.840.10008.5.1.4.1.1.12.2.1**
Nuclear Medicine Image Storage	**1.2.840.10008.5.1.4.1.1.20**
Raw Data Storage	**1.2.840.10008.5.1.4.1.1.66**
Spatial Registration Storage	**1.2.840.10008.5.1.4.1.1.66.1**
Spatial Fiducials Storage	**1.2.840.10008.5.1.4.1.1.66.2**
Real World Value Mapping Storage	**1.2.840.10008.5.1.4.1.1.67**
VL Endoscopic Image Storage	**1.2.840.10008.5.1.4.1.1.77.1.1**
Video Endoscopic Image Storage	**1.2.840.10008.5.1.4.1.1.77.1.1.1**
VL Microscopic Image Storage	**1.2.840.10008.5.1.4.1.1.77.1.2**
Video Microscopic Image Storage	**1.2.840.10008.5.1.4.1.1.77.1.2.1**
VL Slide-Coordinates Microscopic Image Storage	**1.2.840.10008.5.1.4.1.1.77.1.3**
VL Photographic Image Storage *	**1.2.840.10008.5.1.4.1.1.77.1.4**
Video Photographic Image Storage	**1.2.840.10008.5.1.4.1.1.77.1.4.1**
Ophthalmic Photography 8 Bit Image Storage *	**1.2.840.10008.5.1.4.1.1.77.1.5.1**
Ophthalmic Photography 16 Bit Image Storage *	**1.2.840.10008.5.1.4.1.1.77.1.5.2**
Stereometric Relationship Storage	**1.2.840.10008.5.1.4.1.1.77.1.5.3**
Basic Text SR	**1.2.840.10008.5.1.4.1.1.88.11**
Enhanced SR	**1.2.840.10008.5.1.4.1.1.88.22**
Comprehensive SR	**1.2.840.10008.5.1.4.1.1.88.33**
Procedure Log Storage	**1.2.840.10008.5.1.4.1.1.88.40**
Mammography CAD SR	**1.2.840.10008.5.1.4.1.1.88.50**
Key Object Selection Document	**1.2.840.10008.5.1.4.1.1.88.59**
Chest CAD SR	**1.2.840.10008.5.1.4.1.1.88.65**
X-Ray Radiation Dose SR	**1.2.840.10008.5.1.4.1.1.88.67**
Encapsulated PDF Storage	**1.2.840.10008.5.1.4.1.1.104.1**
Positron Emission Tomography Image Storage	**1.2.840.10008.5.1.4.1.1.128**
RT Image Storage	**1.2.840.10008.5.1.4.1.1.481.1**
RT Dose Storage	**1.2.840.10008.5.1.4.1.1.481.2**
RT Structure Set Storage	**1.2.840.10008.5.1.4.1.1.481.3**
RT Beams Treatment Record Storage	**1.2.840.10008.5.1.4.1.1.481.4**
RT Plan Storage	**1.2.840.10008.5.1.4.1.1.481.5**
RT Brachy Treatment Record Storage	**1.2.840.10008.5.1.4.1.1.481.6**
RT Treatment Summary Record Storage	**1.2.840.10008.5.1.4.1.1.481.7**
RT Ion Plan Storage	**1.2.840.10008.5.1.4.1.1.481.8**
RT Ion Beams Treatment Record Storage	**1.2.840.10008.5.1.4.1.1.481.9**

Table 0-5: Required VistA Imaging Storage SOP Classes

0.6 Approach and Terminology

0.6.1 IHE Profiles vs. DICOM Conformance Statements

Additional to PACS DICOM conformance requirements implications, IHE Profiles are
based on Use Cases with detailed definition of Actor behaviors, where the Actors
perform coordinated, standards-based transactions. The Profiles describe the set of

transactions in progressively greater depth to constrain the standard and remove ambiguities.

0.6.2 IHE Profiles' View

All presented profiles preserve the PACS's point of view, however VistA Imaging implications and behavior are detailed as well when necessary.

0.6.3 DICOM Nomenclature for DIMSE Services

The building blocks of SOP Classes are Modules and DIMSE Services. The DIMSE Services associated with a SOP Class may be Mandatory (M) or Optional (U). The usage may be different for the SCU and SCP. The usage is specified as a pair of letters: the former indicating the SCU usage, the latter indicating the SCP usage.

The meaning and behavior of the usage specification for DIMSE Services are:

SCU/SCP	DIMSE Service Meaning and Behavior
M/M	The SCU shall support the DIMSE Service but is not required to use it on an Association. The SCP shall support the DIMSE Service.
U/M	The SCU may support and use the DIMSE Service. The SCP shall support the DIMSE Service.
U/U	The SCU may support and use the DIMSE Service. The SCP may support the DIMSE Service. If the SCP does not support the DIMSE Service used by the SCU, it shall return a Failure status.

0.6.4 DICOM Nomenclature for Static IOD Attribute Elements

Modules and their usage in Composite IODs are defined in PS 3.3[2]. Normalized IODs are also constructed from Modules but usage is specified on an attribute basis in Part 4 of the DICOM Standard. The following usage specification applies to all Attributes of Normalized IODs unless superseded by a usage specification in a particular SOP Class Specification.

The meaning and behavior of the usage specification for Attributes of Normalized IODs are as follows:

SCU/SCP	Normalized IOD Attribute Usage Specification
1/1	The SCU shall provide a value for the Attribute. If the SCU does not supply a value, the SCP shall return a Failure status ("Missing Attribute," code 0120H). The SCP shall support the Attribute. The SCP shall not support null values (attribute provided with a zero length and no value) for the Attribute.

---

[2] For additional, explicitly noted Modality Worklist and Modality Performed Procedure Step related field population details, see *Joint VA / DoD Requirements for Digital Acquisition Modality Devices;* Table 11, Page 27.

SCU/SCP	Normalized IOD Attribute Usage Specification
3/1	The SCU may retrieve or provide a value for the Attribute. The SCP shall support the Attribute. The SCP shall not support null values (attribute provided with a zero length and no value) for the Attribute.
-/1	The SCU's usage of the Attribute is undefined. The SCP shall support the Attribute. The SCP shall not support null values (attribute provided with a zero length and no value) for the Attribute.
2/2	The SCU shall retrieve or provide a value for the Attribute. The SCU shall always provide the attribute but a null value shall be permitted (attribute provided with a zero length and no value). The SCP shall support the Attribute and permit null values (attribute provided with a zero length and no value) for the Attribute.
3/2	The SCU may retrieve or provide a value for the Attribute. The SCP shall support the Attribute and permit null values (attribute provided with a zero length and no value) for the Attribute.
-/2	The SCU's usage of the Attribute is undefined. The SCP shall support the Attribute and permit null values (attribute provided with a zero length and no value) for the Attribute.
3/3	The SCU may retrieve or provide a value for the Attribute. The SCP may support the Attribute. If the SCP does not support the Attribute and it is requested by the SCU, the SCP shall return a Warning status ("Invalid Attribute value", code 0106H). If the SCP does not support the Attribute and the SCU provides it, the attribute shall be ignored.

If the SCP usage type designation is modified by a "C" (e.g., 3/1C) the specification stated above shall be modified to include the requirement that the SCP shall support the Attribute if the specified condition is met.

For all N-CREATE, N-SET, N-GET, N-DELETE, N-ACTION and N-EVENT-REPORT operations, the SOP Class is conveyed in the request primitive in Affected SOP Class UID (0000,0002). The SOP Class UID (0008,0016) Attribute shall not be present in the Data Set.

For N-CREATE operations and N-EVENT-REPORT notifications, the SOP Instance is conveyed in Affected SOP Instance UID (0000,1000). The SOP Instance UID (0008,0018) Attribute shall not be present in the Data Set.

> Note: In some Service Classes, the SOP Class definition may override the general provision in PS 3.7 that allows the SOP Instance UID to be specified or omitted in the N-CREATE request primitive, and require that the SCU be responsible for specifying the SOP Instance UID.

For N-SET, N-GET, N-ACTION and N-DELETE operations, the SOP Instance is conveyed in Requested SOP Instance UID (0000,1001). The SOP Instance UID (0008,0018) Attribute shall not be present in the dataset.

0.6.5 IHE Notation for DICOM Static IOD Attribute Elements

For some DICOM transactions described in this document, IHE has strengthened the requirements on the use of selected Type 2 and Type 3 attributes. These situations are explicitly documented in IHE RAD TF-2 section 4 and in its appendices.

IHE specifically emphasizes that DICOM Type 2 attributes (for instance, Patient Name, Patient ID) shall be transmitted with zero length if the source system does not possess valid values for such attributes; in other words, the source system shall not assign default values to such attributes. The receiving system must be able to handle zero-length values for such attributes.

IHE has defined requirements related to the support for and use of attributes in DICOM storage transactions by both Service Class Users (SCUs) and Service Class Providers (SCPs):

O   The attribute or its value is optional, i.e., in DICOM it is Type 2 or 3.

R   The attribute is required, and is not an IHE extension of the DICOM requirements; i.e., it is already Type 1 in DICOM, but additional constraints are placed by IHE, for example on the value set that may be used for the attribute.

R+   The Requirement is an IHE extension of the DICOM requirements, and the attribute shall be present with a value in images created by the Acquisition Modality, i.e., is Type 1, whereas the DICOM requirement may be Type 2 or 3.

RC+ The Requirement is an IHE extension of the DICOM requirements, and the attribute shall be present with a value in images created by the Acquisition Modality when the condition is satisfied, i.e., is Type 1C, whereas the DICOM requirement may be Type 2 or 3.

IHE has also defined requirements related to the support for and use of matching and return keys in DICOM queries by both Service Class Users (SCUs) and Service Class Providers (SCPs). Matching keys are used to select instances for inclusion in the response by the Find SCP to the SCU, whereas return keys only return specific data and are not used for matching.

• Required matching key SCU:

A key that the Find SCU shall have the ability to offer to its user as a selection criterion. The definition of the means offered to the user of the Find SCU to trigger the sending of a matching key in the Query request is beyond the scope of IHE (e.g. enter a value, select an entry).

• Required matching key SCP:

An IHE required matching key is processed by the Find SCP just as if it were a DICOM-required matching key. In most cases, IHE-required matching keys are also DICOM-required matching keys.

• Required return key SCU:

A key that the Find SCU requests from the Find SCP, receives in the query responses, and displays for the user, if required. The definition of the means offered to the user of the Find SCU to request a return key (e.g. by default, check a box) and to make it visible to the user is beyond the scope of IHE.

• Required return key SCP:

IHE-required return keys specified within DICOM as type 1 or type 2 return keys are processed according to their DICOM type. IHE-required return keys specified within DICOM as type 3 will be processed as if they were type 2.

Query Key Requirement Tables in the framework use the following legend to specify requirements for SCUs and SCPs:

> R   Required
>
> O   Optional

The following modifiers are also used:

> R+   The Requirement is an IHE extension of the DICOM requirements
>
> R*   The attribute is not required to be displayed
>
> R+* The Requirement is an IHE extension of the DICOM requirements, but it is NOT required to be displayed

0.6.6 IHE and VistA Imaging Notation for C-FIND Matching Rules

The tables in Study, Series and Composite Object Instance (Image) Level queries indicates the Matching Type and Modes expected by the VistA Imaging QI **Find SCP** and required as a minimum by the PACS **Q/R Provider AE SCU**:

> **S** indicates the identifier attribute can specify Single Value Matching
>
> **r** indicates Range Matching,
>
> ***** indicates wildcard matching,
>
> **U** indicates universal matching

UNIQUE indicates that this is the Unique Key for that query level, in which case Universal Matching or Single Value Matching is used depending on the scope of the query. ("L" would indicate that UID lists are supported for matching and "NONE" would indicate that no matching is required, but that values for this Element in the database can be returned.)

Note that DICOM standard settings are amended by IHE profile requirements (Required+ Matching Types and IHE-1/2/3/4 notion):

IHE-1: Case insensitive matching is allowed for attributes of VR PN per the approved DICOM Change Proposal (CP 190).

IHE-2: SCUs are recommended to append a wildcard character "*" at the end of each component of any structured name to facilitate matching (i.e., PN attributes).

IHE-3: Universal Matching (selecting return keys) against an Attribute of VR SQ, may be requested by the Find SCU using a Zero Length Sequence Attribute. Find SCPs shall accept such Universal Match Requests. In addition, Find SCPs are required by the DICOM Standard to support requests for a Universal Match for an SQ attribute encoded as a zero length item.

IHE-4: A SOP Class UID is a non-ambiguous key to identify a specific type of image (Modality is not).

1 PACS IAN User AE – Instance Availability Notification (IAN) Consumer Profile

1.1 Use Case

IHE RAD TF-3: 4.49 (**Rad-49**) with different Actors:
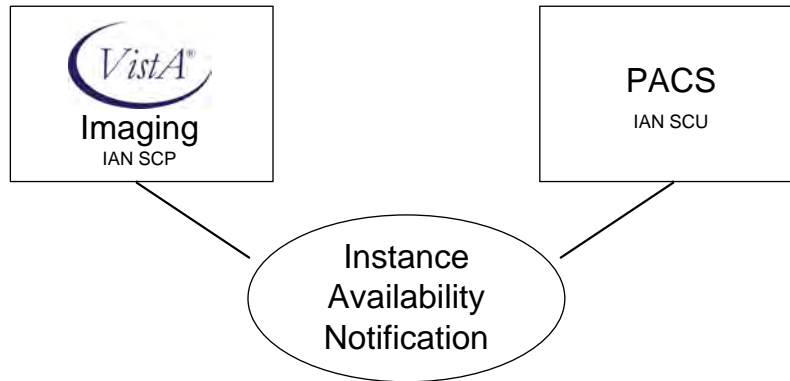
Actor: **VistA Imaging – IAN SCP** (IHE Post-Processing Manager)

Role: Receive Instance Availability Notification from commercial PACS and temporarily store this information until all listed objects are transferred to VistA Imaging.

Actor: **PACS – IAN SCU** (IHE Image Manager / Image Archive)

Role: Send Instance Availability Notification when Studies or select group of Composite Object Instances become available on the PACS.

1.2 Interactions

The actors in this use case shall perform the behaviors shown in the following sequence diagram.
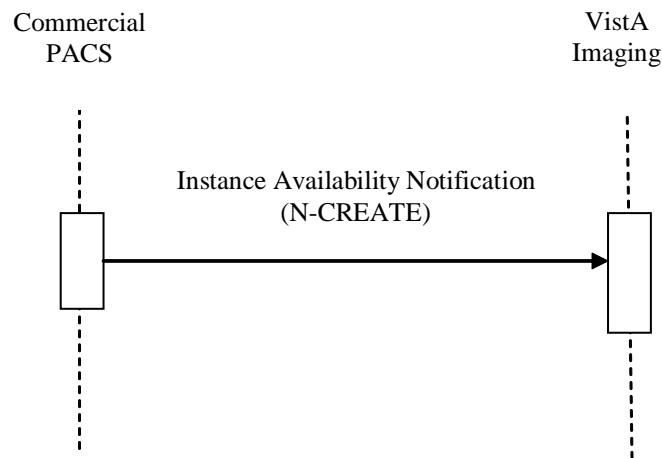
1.3 Dynamic Definitions

The Instance Availability Notification (IAN) Service Class defines an application-level class of service that allows one DICOM AE (on the PACS) to notify another DICOM AE (on VistA Imaging) of the presence and availability of Composite Object Instances (like images) that may be retrieved. This mechanism provides the timely information needed by VistA Imaging to verify existence of those objects in the PACS database, and if needed, to retrieve those newly generated composite objects from the PACS. In the Instance Availability Notification Transaction, an Image Manager/Image Archive (PACS) sends a message to relevant actors (including VistA Imaging) to inform them of the availability status of newly stored DICOM objects associated with a particular study or performed procedure.

The PACS's **IAN User AE** is an Instance Availability Notification Service Class User (SCU) that permits the PACS to send examination and diagnostic identification information to the VistA Imaging IAN SCP, using an N-CREATE DIMSE Service Element. This message includes a list of the examination's Study, Series, and SOP Instance UIDs.

This mechanism provides the information needed by VistA Imaging to retrieve every related composite object from the PACS. (It is recommended that the PACS also automatically route every acquired and/or generated Composite Object Instance to the VistA Imaging Store SCP as soon as they are available.)

According to the DICOM standard, an IAN message covers an entire Study, an arbitrary Study fragment, or a Modality Performed Procedure Step (MPPS) defined segment of the Study. There may be one or more Series related to the Study/MPPS. These Series are stored in a Series Sequence. There may be one or more DICOM Composite Object Instances per Series. All DICOM objects are stored in SOP Sequence Elements of the related Series Sequence. This structure reflects the Study-Series-Instance hierarchy used by the DICOM standard. There is no Patient information, Accession Number or other non-UID type of study/series/instance identifying information in the IAN message.

The IAN message provides the DICOM instance manifest in a timely manner to VistA Imaging (and other relevant actors) for use in a variety of applications (archiving, teleradiology, advanced visualization systems, etc.). For this reason, the PACS is required to issue IAN messages for Acquisition Modality created sets of instances as well as imported instances and Evidence Objects. The PACS shall be able to send the IAN messages to multiple relevant actors, including VistA Imaging.

1.3.1 Business Requirements

1.3.1.1   The IAN Implementation

It is assumed that, upon new DICOM Object Instance(s) availability, the PACS IAN SCU will generate an IAN message, will send it to the VistA Imaging IAN SCP and will wait for an IAN SCP response.

1.3.1.2   Trigger Event

When MPPS messages are supported between the Acquisition Modality Device and the PACS, the PACS shall generate the IAN message upon receiving an MPPS Completed message from the Acquisition Modality Device but not before all the Object Instances referenced in the MPPS become available on the PACS. One IAN message shall be sent for each MPPS that contains references to PACS resident Object Instances. A MPPS without references to Object Instances shall not trigger the sending of an IAN message.

In the case of a non-MPPS-capable Acquisition Modality Device, the PACS shall generate the IAN message when it determines it has a complete set of instances. This is generally the same time that the PACS would put the study on its own reading worklist.

Regardless of the trigger cases above, the PACS can optionally auto-route available Object Instances to VistA Imaging.

1.3.1.3   PACS Declares IAN Conditions

The PACS IAN SCU implementation must define the conditions under which it provides the notification (DICOM PS 3.4-2008, R.1.1):

- Condition A: for arbitrary sets of Object Instances (Study or Study fragment) or

- Condition B: whenever the PACS determines that all instances have been received based on the associated Completed MPPS message.

1.3.1.4   PACS Makes IAN Referred Object Instances Available

The IAN Consumer Profile implementation assumes the PACS will provide a list of all DICOM Object Instance UIDs and their on-line or near-line availability for retrieval.

1.3.1.5   PACS Can Send Follow-Up IAN Messages

Once an IAN is issued for a Study/PPS, subsequent PACS IAN messages are required if any new Series or Composite Object Instances are added to the Study/PPS.

1.3.1.6   PACS Behavior on Object Change

Any changes to a DICOM Composite Object Instance shall re-generate an IAN Request message.

1.3.1.7   PACS Behavior on Failed IAN Request

The PACS IAN SCU shall correct and resend a failed IAN Request message if correction is possible.

1.3.1.8   PACS Responsiveness to Retrieve Requests

Upon successful delivery of an IAN message, the PACS shall be immediately ready (without latency period) to serve VistA Imaging initiated retrieval of the corresponding DICOM Object Instances.

1.3.1.9   VistA Imaging Response to IAN Messages

Upon receipt of an IAN message, VistA Imaging will issue a Study Root Study, Series or Image Level Move request to the PACS to retrieve referenced Object Instances that are

missing from the VistA Imaging database. The PACS shall support such DICOM Move requests, initiate a connection to a VistA Imaging C-STORE AE and transfer the requested DICOM Object Instance(s) (see Chapters 3 and 4).

1.3.1.10 Retrieve AE Title Specifics

The PACS shall be able to respond to Retrieve (C-MOVE) requests and deliver DICOM Object Instances to an AE other than the VistA Imaging Notification (IAN) SCP AE.

1.3.1.11 No User Characteristics

The IAN Consumer Profile implements a system-to-system interface. No User Characteristics are defined or assumed.

1.3.2 Error Handling

1.3.2.1   Confirm PACS IAN Request Message

Verify that the request meets the DICOM standard and IHE profile definitions.

1.3.2.2   Return a Reject Response Message to the PACS

The purpose of this message is to determine what the PACS does in this use case.

1.3.3 Functional Requirements

1.3.3.1   Message Type

DICOM defines (PS 3.4-2008, R.1.1) two types of IAN messages: "Certain SCUs may provide notification for arbitrary sets of SOP Instances, while other SCUs may provide notification when it is determined that the instances associated with a Modality Procedure Step (MPPS)."

One type does not contain PPS information; the other does contain PPS information (PS 3.3-2008, Table C.4.23-1). IHE only acknowledges (2007-Rev. 8, Vol. 3, .49.4.1.1) an IAN message containing the PPS information. VistA Imaging will support IAN messages, regardless whether or not they contain PPS information.

1.3.3.2   IAN SCU

The PACS IAN implementation shall act as an Instance Availability Notification SOP Service Class User (SCU).

1.3.3.3   Presentation Context

The table below lists the proposed presentation contexts that are accepted by VistA Imaging as an **IAN SCP**:

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
Name	**UID**	**Name List**	**UID List**		
Instance Availability Notification SOP Class	1.2.840.10008.5.1.4.33	Implicit VR Little Endian Explicit VR Little Endian	1.2.840.10008.1.2 1.2.840.10008.1.2.1	SCU	None

Table 1-1: IAN Consumer -- Presentation Context

The PACS shall support the **IAN** SOP class as an **SCU**, using one of the listed transfer syntaxes in the table above.

1.3.3.4 Request Message

The PACS shall understand that the issuance of the IAN N-CREATE-RQ message implies that a complete set of SOP Instances is available at the relevant Retrieve AE title that is identified by the Retrieve AE Title (0008, 0054) attribute of each listed Series sequence element of the IAN message.

1.3.3.5 Response Message

The PACS shall wait for an IAN N-CREATE–RSP message from VistA Imaging with a confirmation status completing the IAN N-CREATE service operation.

1.3.3.5.1 Returning Success Response Message

The PACS shall anticipate an IAN N-CREATE-RSP message with a SUCCESS status if the IAN N-CREATE-RQ message completes without warning or error.

1.3.3.5.2 Returning Failed Response Message

The PACS shall anticipate an IAN N-CREATE–RSP with a FAILED status if the IAN N-CREATE-RQ message contains an error. The Failure Status will include the Offending Element (0000, 0901), Error Comment (0000, 0902), and Error ID (0000, 0903).

1.3.3.6 Handling of MPPS References

VistA Imaging will accept the Reference Performed Procedure Step Sequence (0008, 1111) attribute if it exists in the IAN N-CREATE-RQ message.

1.3.3.7 Handling of Storage Media File Set ID

VistA Imaging will ignore the Storage Media File-Set ID (0088, 0130) and the Storage Media File-Set UID (0088, 0140) attributes if they exist in the IAN N-CREATE-RQ message.

1.3.3.8 Persistent Storage of IAN Context

The PACS shall not assume that VistA Imaging is able to reconstruct the IAN N-CREATE message from persistent storage.

1.4 DICOM-Specific Definitions

1.4.1 SOP Class Level Definitions

The PACS IAN SCU shall support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Notification AE	Verification SOP Class	SCU	Verification (DICOM Echo)
	Instance Availability Notification	SCU	Notification from PACS on availability of a Study's / MPPS's Composite Object Instances

Table 1-2: IAN Consumer – SOP Classes

See N-CREATE Response Codes under IOD Level Definitions below.

1.4.1.1 Association Establishment Policies

1.4.1.1.1 General

The VistA Imaging **IAN SCP** accepts but never initiates connections. The maximum PDU size offered by the MIS **Store SCP** is 32768 bytes by default but later, during association negotiation, can be altered. SOP Class Extended Negotiation is not supported.

The DICOM standard Application Context (1.2.840.10008.3.1.1.1) will be specified.

Multiple IAN requests may be handled during an Association in a sequential fashion.

1.4.1.1.2 Number of Simultaneous Associations

The VistA Imaging **IAN SCP** can handle multiple associations. The maximum number of simultaneous associations the MIS **IAN SCP** will maintain is limited only by system (mainly memory and processor) resources.

1.4.1.2 Association Acceptance Policy

The IAN **Notification User AE** SCU shall not accept associations.

1.4.2 IOD Level Definitions

See the IAN N-CREATE request IOD definition in the next sub-section.

1.4.2.1 Message Attributes

The PACS IAN SCU Implementation shall comply with the N-CREATE DIMSE Service specified in Table 1-3: IAN Consumer -- IAN SOP Class N-CREATE Attributes. This table is from the DICOM Standard (PS 3.4-2008, Annex R, Table R-3.2-1).

Attribute Name	Tag	Req. Type N-CREATE (SCU/SCP)
Specific Character Set	(0008,0005)	1C/1C (Required if an extended or replacement character set is used)
All other Attributes of SOP Common Module		3/3
Referenced Performed Procedure Step Sequence	(0008,1111)	2/2
>Referenced SOP Class UID	(0008,1150)	1/1
>Referenced SOP Instance UID	(0008,1155)	1/1
>Performed Workitem Code Sequence	(0040,4019)	2/2
>>Code Value	(0008,0100)	1/1
>>Coding Scheme Designator	(0008,0102)	1/1
>>Code Meaning	(0008,0104)	1/1
>>All other Attributes from Performed Workitem Code Sequence		3/3
Study Instance UID	(0020,000D)	1/1
Referenced Series Sequence	(0008,1115)	1/1
>Series Instance UID	(0020,000E)	1/1
>Referenced SOP Sequence	(0008,1199)	1/1
>>Referenced SOP Class UID	(0008,1150)	1/1
>>Reference SOP Instance UID	(0008,1155)	1/1
>>Instance Availability	(0008,0056)	1/1
>>Retrieve AE Title	(0008,0054)	1/1
>>Storage Media File-Set ID	(0088,0130)	3/3
>>Storage Media File-Set UID	(0088,0140)	3/3

Table 1-3: IAN Consumer -- IAN SOP Class N-CREATE Attributes

1.4.2.1.1 IAN SCP Response Codes and IAN SCU Behavior

The VistA Imaging **IAN SCP** will return the following N-CREATE Service response codes. The **Notification User AE** (SCU) shall behave as described in the table below.

Response Code (0000,0900)	Meaning	Related Fields	IAN SCU Behavior
0000h	IAN received, processed successfully	none	Success – n/a
0106h	Invalid Attribute Value – an Attribute Value specified was out of range or otherwise inappropriate.	none	Failed logged – retries will apply /w correction
0120h	Missing Attribute – a required Attribute was not supplied	(0000,1005)	Failed logged – retries will apply /w correction
0121h	Missing Attribute Value – a required Attribute Value was missing and a default value was not available	(0000,0902)	Failed logged – retries will apply /w correction
0105h	No Such Attribute – the Tag for the specified Attribute was not recognized	(0000,1005)	Failed logged – retries will apply /w correction
0118h	No Such SOP Class – the SOP Class was not recognized	(0000,0002)	Failed logged – retries will apply /w correction
0213h	Resource Limitation – the operation was not performed due to resource limitation	(0000,0002)	Failed logged – Retry in a while

Table 1-4: IAN Consumer -- Behavior on VistA Imaging IAN SCP Response Codes

1.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert with or above what is provided by the DICOM standard and/or recommended by IHE.

All type 3/3 attributes are ignored by the IAN SCP, however they are checked for DICOM structural correctness if present.

Specific Character Set (0008,0005) – 1C/1C

Can be omitted as only default character set is used.

Referenced Performed Procedure Step (0008,1111) SQ – 2/2

The existence and content of this sequence structure is checked for DICOM validity and conformance but the relevant entity SOP Instance UIDs will be extracted from the Type 1/1 Study Instance UID tag (0020,000D) and Reference Series Sequence (0008,1115) structure below.

Study Instance UID (0020,00D0) UI – 1/1

This field identifies the top (Study) layer entity of the hierarchy (in Condition A or Condition B as well). The Study UID is always required and stored.

Referenced Series (0008,1115) SQ – 1/1

This structure represents the second (Series) layer of the hierarchy (in Condition A or Condition B as well). The Series Sequence content is always required and all non Type 3 fields are processed.

>Series Instance UID (0020,00D0) UI – 1/1

This field identifies the second (Series) layer entity of the hierarchy (in Condition A or Condition B as well). The Series UIDs for all Referenced Series Sequence elements (entities) are always required and processed.

>Referenced SOP (0008,1199) SQ – 1/1

This structure represents the third (Image/Object Instance) layer of the hierarchy (in Case A or Case B as well). The Referenced SOP Sequence content is always required and all non Type 3 fields are processed.

>>Referenced SOP Class UID (0008,1150) UI – 1/1

This field is checked against the list of supported SOP classes. Offending items are skipped and logged; Warning status is returned to SCU.

>>Referenced SOP Instance UID (0008,1155) UI – 1/1

This field represents the third (Series) layer of the hierarchy (in Condition A or Condition B as well). The Series UIDs for all Referenced Series Sequence elements are always required and processed.

>>Instance Availability (0008,0056) CS – 1/1

The Instance Availability (0008, 0056) attribute of an IAN SCU request message may contain one of the following enumerated values; VistA Imaging will accept and recognize these values and meanings as described in the DICOM standard:

- "ONLINE" means the instances are immediately available from the Retrieve AETitle, and if a C-MOVE were to be requested, it would succeed in a reasonably short time.

- "NEARLINE" means the instances need to be retrieved from relatively slow media such as optical disk or tape, and if a C-MOVE were to be requested from the Retrieve AE Title, it would succeed, but may take a considerable time.

- "OFFLINE" means that a manual intervention is needed before the instances may be retrieved, and if a C-MOVE were to be requested from the Retrieve AE Title, it would fail (e.g., by timeout) without such manual intervention.

- "UNAVAILABLE" means the instances cannot be retrieved from the Retrieve AE Title, and if a C-MOVE were to be requested, it would fail. Note that SOP Instances that are unavailable from this AE may be available from other AEs, or may have an alternate representation that is available from this AE.

Any other enumerated value not listed here shall be treated as if the status is "ONLINE".

>>Retrieve AE Title (0008,0054) AE – 1/1

This field must be present for each Instance to identify the Move AE of the SCP that can deliver the Object Instance.

2 PACS Query/Retrieve Provider AE – Image Availability Query (IAQ) Provider Profile

2.1 Use Case

IHE RAD TF-2: 4.11 (**Rad-11**) with different Actors:
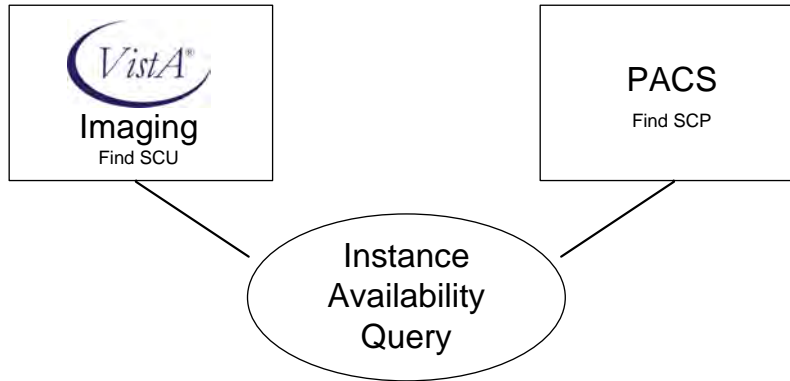
Actor: **VistA Imaging – Find SCU** (IHE DSS/Order Filler)

Role: Issue Find request to receive details, from the PACS, on newly available Study, Series or a select group of Composite Object Instances.

Actor: **PACS – Find SCP** (IHE Image Manager)

Role: Respond to VistA Imaging Find request with Composite Object Instance (image) Level details.

2.2 Interactions

The actors in this use case shall perform the behaviors shown in the following activity diagram.
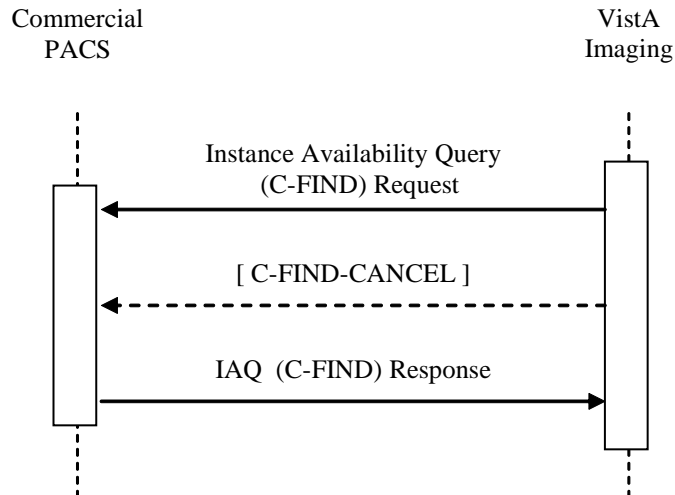
2.3 Dynamic Definition

When there is no IAN message and VistA Imaging learns about the existence of a completed examination from the VistA database ("RIS") via an HL7 "Exam Verified" message, VistA Imaging will issue a query request message containing an Accession Number. The PACS's query response shall return the corresponding Study's unique identifier for that Accession Number. Using this Study identifier, the VistA Imaging Image Availability Query application will issue another query for the list of the relevant Series of the Study and follow-up queries for all the Series of the Study to build a list of all Composite Object Instance (image) unique identifiers of the given Study. Then VistA Imaging will determine which Object Instances have not yet been transferred from the PACS and attempt to retrieve them.

VistA Imaging's **Find SCU** is a Study Root Query/Retrieve Information Model – FIND Service Class User (SCU) that requests information about Composite Object Instances currently known by the PACS. These Objects will be subsequently retrieved by VistA Imaging. The **Find SCU** issues Study/Series/Composite-Object-Instance level C-FIND requests to the PACS's **Q/R Provider AE** (SCP) to collect a list of composite Object Instances that belong to the Study identified in the request. Only Study Root Study/Series/Composite-Object-Instance level queries are supported. The VistA Imaging **Find SCU** AE will also act as a **Move SCU** and issue study root Study/Series/Composite-Object-Instance level C-MOVE requests to Retrieve Composite Object Instances (Images) of the study from the PACS's **Q/R Provider AE** (SCP).

2.3.1 Business Requirements

2.3.1.1 The IAQ Implementation

When there is no IAN message, VistA Imaging will initiate an IAQ request to the PACS **Q/R Provider AE** (SCP) to find out the Study Instance UID for a known VistA Imaging Accession Number. Once the Study Instance UID and/or the relevant Series and SOP Instance UIDs are known, through subsequent hierarchical queries, the VistA Imaging **Move SCU** initiates a Study Root Study, Series or Composite Object Instance Level C-MOVE request to the PACS **Q/R Provider AE** (SCP). The PACS **Q/R Provider AE** (SCP) shall support such DICOM Query and Move requests.

2.3.1.2 Trigger Event

Based on the reception of an HL7 "Exam Verified" message in the absence of a corresponding IAN message, VistA Imaging will issue an IAQ to learn the Study's identity from the PACS and through subsequent hierarchical queries, can obtain a list of UIDs of the Study's Object Instances.

2.3.1.3 PACS Simultaneous Queries

The PACS must declare the number of queries its **Q/R provider AE** SCP can perform simultaneously.

2.3.1.4   PACS Query Performance

The PACS must specify the maximum timeout intervals that can occur between Study/Series/ Composite-Object-Instance level IAQ C-FIND response messages.

2.3.1.5   PACS Priority Processing

The PACS must declare if priority processing is supported or not with respect to other DIMSE operations being performed by the same SCP.

2.3.1.6   PACS Response Message Limitations

The PACS must declare if for a given IAQ C-FIND Request the number of items (response messages) returned is limited by a configuration- or an implementation-specific setting.

2.3.1.7   Retrieve AE Title Specifics

The PACS shall be able to respond to Move Requests from and deliver DICOM Object Instances to a different AE other than the VistA Imaging **Find SCU**.

2.3.1.8   PACS Object Serving Behavior

The VistA Imaging **Find SCU** will request DICOM Object Instance(s) from the PACS by initiating a C-MOVE request to the PACS's **Q/R Provider AE** SCP. Consequently, the PACS shall be able to initiate a connection to a VistA Imaging **Store SCP** AE and transfer the requested DICOM Object Instance(s).

2.3.1.9   No User Characteristics

The IAQ Provider Profile implements a system-to-system interface. No User Characteristics are defined or assumed.

2.3.2 Error Handling

2.3.2.1   Confirm PACS IAQ Find SCP Behavior

Verify that the IAQ response meets the DICOM standard and IHE profile definitions by submitting various correctly and incorrectly formed IAQ Requests.

2.3.2.2   Confirm PACS Find Cancel Behavior

Determine if the PACS can respond to the cancel request in a timely fashion.

2.3.3 Functional Requirements

2.3.3.1   IAQ Find SCP

The PACS IAQ implementation shall act as a Study Root Query/Retrieve Information Model -- FIND Service Class Provider (SCP).

2.3.3.2   Expected IAQ Action

The PACS (IHE Image Manager) IAQ Provider, as the **Q/R Provider AE** SCP shall respond to the **Find SCU**'s C-FIND Request as specified in the DICOM standard, including

returning the SOP Instance UIDs (0008,0018) and corresponding Retrieve AE title (0008, 0054) when a match is successful.

2.3.3.3 Presentation Context

The table below lists the proposed **Q/R Provider AE** SCP presentation context that is anticipated by VistA Imaging as a **Find SCU**:

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
Name	**UID**	**Name List**	**UID List**		
Study Root Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None

Table 2-1: IAQ Provider – Presentation Context

The PACS shall support the Study Root Query/Retrieve Information Model – FIND SOP class as a Service Class Provider, using the listed transfer syntax in the table above.

2.4 DICOM-Specific Definitions

2.4.1 SOP Level Definitions

The PACS IAQ Provider, as a **Q/R Provider AE** SCP should support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Q/R Provider AE	Verification SOP Class	SCP	Verification (DICOM Echo)
	Study Root Query/Retrieve Information Model – FIND	SCP	Query PACS for information about Patient, Study, Series and Instances (Study, Series and Composite-Object-Instance level)

Table 2-2: IAQ Provider – SOP Classes

2.4.1.1 Association Establishment Policies

2.4.1.1.1 General

The maximum PDU size offered by the VistA Imaging IAQ **Find SCU** is 32768 bytes by default but the **Q/R Provider AE** SCP can later alter it during association negotiation. SOP Class Extended Negotiation is not supported. Negotiation of combined date-time matching and fuzzy semantic matching of person names is not supported.

The DICOM standard Application Context (1.2.840.10008.3.1.1.1) will be specified.

2.4.1.1.2 Number of Simultaneous Associations

The maximum number of simultaneous associations the VistA Imaging IAQ **Find SCU** can maintain is limited only by system resources.

2.4.1.2   Association Acceptance Policy

The IAQ Find SCU does not accept associations.

2.4.1.3   IAQ Query SOP Specific Conformance

2.4.1.3.1 Study Root Query/Retrieve Information Model - FIND SOP Class

The SOP Class conforms to the basic requirements set forth by the DICOM standard. All return keys are included in the C-FIND request.

2.4.1.3.2 Expected IAQ Find SCP Behavior

The PACS IAQ Provider, as a **Q/R Provider AE** SCP is requested to perform a match of all the keys specified in the Identifier of the request, against the information it possesses, to the level specified in the request. Attribute matching is performed using the key values specified in the Identifier of the C-FIND request as defined in Section PS3.4.C.2 of the DICOM (2008) standard.

The **Q/R Provider AE** SCP shall generate a C-FIND response for each entity that matches the Identifier in the request. All such responses shall contain an Identifier whose Attributes contain values from a single match. All such responses shall contain a status of Pending.

When all matches have been sent, the **Q/R Provider AE** SCP shall generate a final C FIND response which contains a status of Success. A status of Success shall indicate that a response has been sent for each match known to the SCP.

> Note: When there are no matches, then no responses with a status of Pending shall be sent, only a single response with a status of Success.

The **Q/R Provider AE** SCP shall generate a response with a status of Refused or Failed if it is unable to process the request. A Refused or Failed response shall contain no Identifier.

2.4.1.3.3 IAQ Find SCU Behavior on IAQ Find SCP Responses

The VistA Imaging IAQ Consumer, as a **Find SCU,** will behave as described in the table below; that is how the **Find SCU** AE responds to the status returned in the **Q/R Provider AE** C-FIND SCP response message.

Service Status	Further Meaning	Status Codes (0000,0900)	Related Fields	C-FIND SCU Behavior
Success	Matching is complete—no final identifier is supplied	0000	None	Initiate item(s) retrieval if applicable
Refused	Out of Resources	A7xx	(0000,0902)	Logged, retries will apply
Error	Identifier does not match SOP Class	A9xx	(0000,0901) (0000,0902)	Logged.
	Unable to process	Cxxx	(0000,0901) (0000,0902)	Logged.
Cancel	Matching terminated due to cancel request	FE00	None	Taken as Successfully Canceled Request
Pending	Matches are continuing	FF00	Identifier	Monitored
	Matches are continuing-warning that one or more optional keys are not supported	FF01	Identifier	Monitored

Table 2-3: IAQ Provider -- VistA Imaging Behavior on PACS SCP Response Status

2.4.1.3.4 *Retrieve AE Title*

Per the DICOM standard, Retrieve AE Title (0008,0054) shall be supported and returned by the Image Manager (i.e. **Q/R Provider AE** SCP) as part of the response.

2.4.1.3.5 *Storage Media File-Set Attributes*

Storage Media File-Set ID (0088,0130) and Storage Media File-Set UID (0088,0140) are not used by VistA Imaging.

2.4.1.3.6 *Instance Availability Option*

To better quantify Access Time, the optional attribute Instance Availability (0008,0056) with enumerated values of "ONLINE", "NEARLINE" and "OFFLINE" shall be supported by the PACS, except if all items are rapidly accessible on-line (under 30 seconds). In terms of access times and implications on subsequent Retrieve (C-MOVE) request, the Image Availability values for the PACS, unless all Object Instances are on-line, shall return the following Levels:

Level	Description	Access time
ONLINE	Images can be retrieved from storage location and be ready for distribution within a reasonable period of time (what time is	Seconds to a minute

	reasonable is implementation-specific)	
NEARLINE	Before distribution, images has to be processed/staged at a storage location; total retrieval time is longer than "reasonable"	Minute to an hour
OFFLINE	Image cannot be distributed without human user intervention	Minutes to Hours to days

<div align="center">**Table 2-4: IAQ Provider– Composite Object Instance Access Time Levels**</div>

An empty Instance Availability field will be taken as ONLINE.

2.4.1.3.7 *C-FIND-CANCEL Support*

The PACS shall respond to a C-FIND-CANCEL to terminate the C-FIND Request. The SCU will recognize a response status of Canceled to indicate that the C-FIND-CANCEL was successful.

2.4.2 IOD Level Definitions

2.4.2.1 Message Attributes

The PACS IAQ Provider, as a **Q/R Provider AE** SCP Implementation shall comply with the C-FIND DIMSE Service specified in the DICOM Standard (PS 3.4-2008, Annex C). The **Q/R Provider AE** SCP shall conform to the DICOM standard as a Study Root Study, Series and Composite-Object-Instance Level C-MOVE SCP with the following simplifications.

2.4.2.1.1 *Default Character Set Support*

The VistA Imaging IAQ Consumer, as a **Find SCU** uses the default character set of ISO-IR 6 when encoding queries and expecting the same encoding in the **Q/R Provider AE** SCP generated responses of the IAQ Provider.

The PACS shall not expect the Specific Character Set Attribute (0008,0005).

2.4.2.1.2 *Supported Study Root Query Levels and Search Schemes*

Study Root Study/Series/Composite Object Instance Level queries are generated. Relational searches are not supported yet but might be in the future. The following table describes the **Q/R Provider AE** (C-FIND) SCU Request attributes for the different level queries of the Study Root Hierarchical Information Model:

Attribute	Tag	Study Level Query Key Value	Series Level Query Key Value	COI (Image) Level Query Key Value
Query/Retrieve Level	(0008,0052)	STUDY	SERIES	IMAGE
Study Instance UID	(0020,000D)	1. zero length value for Study UID search or 2. Unique value for single-value match	Unique value for single-value match	Unique value for single-value match

Series Instance UID	(0020,000E)	Attribute omitted	1. zero length value for Series UIDs search or 2. Unique value for single-value match	Unique value for single-value match
SOP Instance UID	(0008,0018)	Attribute omitted	Attribute omitted	1. zero length value, 2. Single value, or 3. list of UIDs

Table 2-5: IAQ Provider – Study Root Query Level Related Instance UID Settings

2.4.2.1.3 *VistA Imaging Specific and Optional Keys*

Most optional keys were not supported in earlier VistA Imaging implementations. Future implementations will support all listed optional keys. In the following three sections (2.4.2.1.4, 2.4.2.1.5, and 2.4.2.1.6) the earlier VistA Imaging Requirements are highlighted while the rest of the keys and fields reflect conformance to upcoming implementations.

2.4.2.1.4 *Study Level Matching Keys*

C-FIND Matching Rule Notations are detailed in the introduction under 0.6.6.

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Query/Retrieve Level ("STUDY")	**(0008,0052)**	**Required +**	**Required**	**S**
Study Date	**(0008,0020)**	**Required +**	**Required**	**S, r, U**
Study Time	(0008,0030)	Required +	Required	r, U
Study ID	(0020,0010)	Required +	Required	S, *, U
Patient's Name (IHE-1/2)	**(0010,0010)**	**Required +**	**Required**	**S, *, U**
Patient ID	**(0010,0020)**	**Required +**	**Required**	**S, *, U**
Accession Number	**(0008,0050)**	**Required +**	**Required**	**S, *, U**
Study Instance UID	**(0020,000D)**	**UNIQUE - R+**	**UNIQUE - R**	**UNIQUE**
Modalities in Study	(0008,0061)	Required +	Required +	S, *, U
Referring Physician's Name (IHE-1/2)	(0008,0090)	Required +	Required +	S, *, U
Study Description	(0008,1030)	Optional	Optional	S, *, U
Procedure Code Sequence	(0008,1032)	Optional	Optional	S
>Code Value	(0008,0100)	Optional	Optional	S, U
>Coding Scheme Designator	(0008,0102)	Optional	Optional	U
>Coding Scheme Version	(0008,0103)	Optional	Optional	U
>Code Meaning	(0008,0104)	Optional	Optional	U

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Name of Physician(s) Reading Study (IHE-1/2)	(0008,1060)	Optional	Optional	S, *, U
Other Patient IDs	(0010,1000)	Optional	Optional	S, *, U
Other Patient Names (IHE-1/2)	(0010,1001)	Optional	Optional	S, *, U
Patient's Age	(0010,1010)	Optional	Optional	U
Patient's Birth Date	(0010,0030)	Optional	Optional	S, *, U
Patient's Sex	(0010,0040)	Optional	Optional	S, *, U
Patient's Size	(0010,1020)	Optional	Optional	S, *, U
Patient's Weight	(0010,1030)	Optional	Optional	S, *, U
Ethnic Group	(0010,2160)	Optional	Optional	S, *, U
Interpretation Author (IHE-1/2)	(4008,010C)	Optional	Optional	S, *, U

Table 2-6: IAQ Provider – Study Root/Study Level Matching Keys

Other Study Level VistA Imaging extensions applied are:

Attributes Name	Tag	Required Keys	
		SCU	SCP
Patient's Birth Date	(0010,0030)	Required +	Required +
Patient's Sex	(0010,0040)	Required +	Required +
Number of Study Related Series	(0020,1206)	Optional	Required +
Number of Study Related Instances	(0020,1208)	Optional	Required +

Table 2-7: IAQ Provider – Study Root/Study Level VistA Imaging Required Keys

Date matching follows the default DICOM standard Range matching pattern with no extended negotiation.

2.4.2.1.5 Series Level Matching Keys

C-FIND Matching Rule Notations are detailed in the introduction under 0.6.6.

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Query/Retrieve Level ("SERIES")	**(0008,0052)**	**Required +**	**Required**	**S**
Modality	(0008,0060)	Required +	Required	S, *, U
Series Number	(0020,0011)	Required +	Required	*, U

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Series Instance UID	**(0020,000E)**	**UNIQUE - R+**	**UNIQUE - R**	**UNIQUE**

Table 2-8: IAQ Provider – Study Root/Series Level Matching Keys

Other Series Level VistA Imaging extensions applied are:

Attributes Name	Tag	Required Keys	
		SCU	**SCP**
Series Description	(0008,103E)	Required +	Required +
Number of Series Related Instances	(0020,1209)	Optional	Required +

Table 2-9: IAQ Provider – Study Root/Series Level VistA Imaging Required Keys

2.4.2.1.6 *Object Instance Level Matching Keys*

C-FIND Matching Rule Notations are detailed in the introduction under 0.6.6.

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Query/Retrieve Level ("IMAGE")	**(0008,0052)**	**Required +**	**Required**	**S**
Instance Number	(0020,0013)	Required +	Required	S, *, U
SOP Instance UID	**(0008,0018)**	**UNIQUE - R+**	**UNIQUE - R**	**UNIQUE**
SOP Class UID (IHE-4)	**(0008,0016)**	**Optional**	**Required +**	*

Table 2-10: IAQ Provider – Study Root/Object Instance Level Matching Keys

Attributes Name	Tag	Required Keys	
		SCU	**SCP**
Row	(0008,0010)	Optional	Required +
Column	(0008,0011)	Optional	Required +
Bits Allocated	(0008,0100)	Optional	Required +
Number of Frames	(0028,0008)	Optional	Required +

Table 2-11: IAQ Provider – Study Root/Instance Level, Image Specific VistA Imaging Required Keys

2.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert or above what is provided by the DICOM standard and/or recommended by IHE.

<Information may come as needed.>

3 PACS Query/Retrieve Provider AE – Retrieve Images (RI) Provider Profile

3.1 Use Case

IHE RAD TF-2: 4.16 (**Rad-16**) with different Actors:
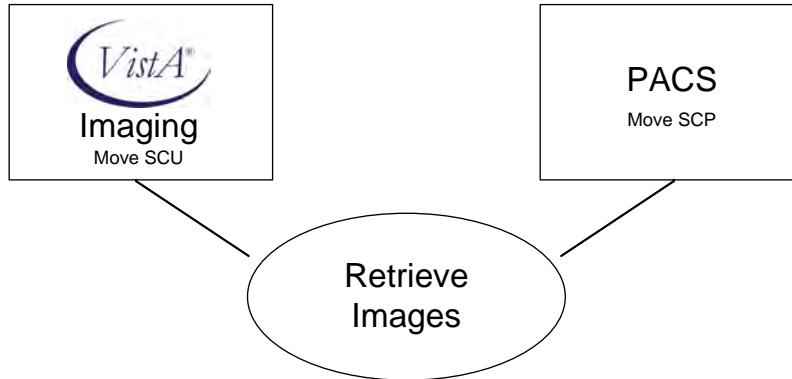
Actor: **VistA Imaging – Move SCU** (IHE Image Display)

Role: Retrieve Composite Object Instances (Images) of a Study, a Series or selected list from the PACS.

Actor: **PACS – Move SCP** (IHE Image Archive)

Role: Respond to VistA Imaging's Retrieve Images request by delivering Composite Object Instances (images) of a Study, a Series or a selected list to VistA Imaging.

3.2 Interactions

The actors in this use case shall perform the behaviors shown in the following sequence diagram.
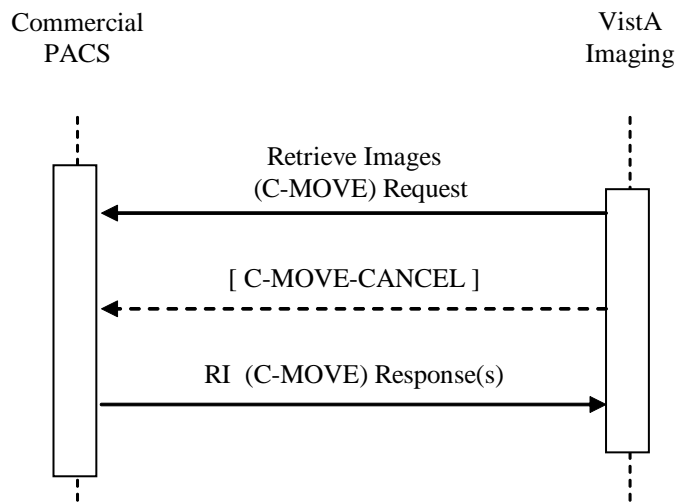
3.3 Dynamic Definition

The VistA Imaging Move Request message created by the **Move SCU** service contains the Study Instance UID, a Series Instance UID or the individual SOP Instance UIDs. This Move Request message requests the PACS **Q/R Provider AE** to send all listed DICOM Object Instances to the **Store SCP** process running on VistA Imaging. The destination C-STORE SCP AE is specified in the Move request.

VistA Imaging's **Move SCU** is a Study Root Query/Retrieve Information Model - MOVE Service Class User (SCU) that allows Composite Object Instances available on the PACS to be retrieved by VistA Imaging. The **Move SCU** uses C-MOVE requests to instruct the PACS **Q/R Provider AE** to initiate the issuance of C-STORE requests through PACS's **Storage User AE** to transfer Composite Object Instances to VistA Imaging's **Store SCP**. The VistA Imaging **Find SCU** is also a Study Root Query/Retrieve Information Model - FIND Service Class User (see IAQ Provider Profile in Chapter 2) that can issue C-FIND queries to obtain information about studies on the PACS.

3.3.1 Business Requirements

3.3.1.1   The RI Implementation

The VistA Imaging **Move SCU** will issue the appropriate DICOM Move request to the PACS **Q/R Provider AE**. The **Move SCU** will initiate a Study Root Study, Series or Composite Object Instance Level Move request to the PACS. The PACS's **Q/R Provider AE** SCP shall support such DICOM Move requests.

3.3.1.2   Trigger Event

There are two Retrieve Images (RI) trigger sources for VistA Imaging:

>*Case A:* Based on the reception of an IAN message, VistA Imaging will examine its database if the IAN contained Object Instances are missing from its database.

>*Case B:* Based on the reception of an HL7 "Exam Verified" message in the absence of an IAN message, VistA Imaging will issue an IAQ query to learn the Study's identity from the PACS and obtain a list of the identifiers of the Study's Object Instances.

When VistA Imaging had determined which Object Instances are missing from its database, as an RI Consumer, its **Move SCU** can issue a Move request to the PACS for the missing Object Instances.

3.3.1.3   PACS Simultaneous Moves

The PACS must declare the number of moves its **Q/R Provider AE** SCP can perform simultaneously.

3.3.1.4   PACS Move Performance

The PACS must specify the maximum timeout intervals that can occur between Study/Series/Composite-Object-Instance level **Q/R Provider AE** C-MOVE response messages for ONLINE and NEARLINE stored Object Instances.

3.3.1.5   PACS Priority Processing

The PACS must declare if priority processing is supported or not with respect to other DIMSE operations being performed by the same SCP.

3.3.1.6   PACS Response Message Limitations

The PACS must declare if for a given **Q/R Provider AE** C-MOVE SCP Request the number of items (response messages) returned is limited by a configuration or an implementation specific setting.

3.3.1.7   Retrieve AE Title Specifics

The PACS shall be able to respond to query requests from the VistA Imaging **Move SCU** and deliver DICOM Object Instances to another AE.

3.3.1.8   PACS Object Serving Behavior

VistA Imaging will request DICOM Object Instance(s) from the PACS by initiating a C-MOVE request to the PACS. Consequently, the PACS shall be able to initiate a connection and to transfer the requested DICOM Object Instance(s) to the VistA Imaging **Store SCP**.

3.3.1.9   No User Characteristics

The RI Provider, as a **Q/R Provider AE** SCP, implements a system-to-system interface. No User Characteristics are defined or assumed. Consequently, the IHE RAD TF-2: 4.16 Viewing related clauses do not apply in this Profile. Waived IHE RAD TF-2 sections are: 4.16.4.1.1 Trigger Events, and the entire section of 4.16.4.2 View Images.

3.3.2 Error Handling

3.3.2.1   Confirm PACS RI Move SCP Behavior

Verify that the Move response meets the DICOM standard and IHE profile definitions, by submitting various C-MOVE Requests (without running Store SCP, failing Store SCP, forced error cases).

3.3.2.2   Confirm PACS Move Cancel Behavior

Determine if the PACS can respond to the cancel request in a timely fashion.

3.3.3 Functional Requirements

3.3.3.1 RI Move SCP

The PACS RI Provider, as a **Q/R Provider AE** SCP implementation, shall act as a Study Root Query/Retrieve Information Model -- MOVE Service Class Provider (SCP).

3.3.3.2 Expected RI Action

The PACS (IHE Image Manager) **Q/R Provider AE** SCP shall respond to the SCU's C MOVE Request as specified in the DICOM standard, delivering requested SOP Instances via C-STORE operations to specified Move Destination (C-STORE SCP) AE title(s) (0000, 0060).

3.3.3.3 Presentation Context

The table below lists the proposed presentation context for the **Q/R Provider AE** that is anticipated by VistA Imaging as a **Move SCU**:

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
Name	**UID**	**Name List**	**UID List**		
Study Root Query/Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		

Table 3-1: RI Provider – Presentation Context

The PACS RI Provider shall support the C-MOVE SOP class as the **Q/R Provider AE** SCP, using the listed transfer syntax in the table above.

3.3.3.4 Request Message

The PACS **Q/R Provider AE** SCP shall be able to serve Study Root Study, Series and Composite Object Instance Level moves at a minimum.

3.4 DICOM-Specific Definitions

3.4.1 SOP Level Definitions

The PACS RI Provider, as a **Q/R Provider AE** SCP, shall support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Q/R Provider AE	Verification SOP Class	SCP	Verification (DICOM Echo)
	Study Root Query/Retrieve Information Model – MOVE	SCP	Handle and follow up on transfer requests of Composite Object

			Instance(s) by Executing Study, Series and Composite-Object-Instance Level Move operations

<div align="center">**Table 3-2: RI Provider – SOP Classes**</div>

3.4.1.1   RI Move SOP Specific Conformance

3.4.1.1.1 Expected Move SCP Behavior

It is recommended that the PACS RI Provider, as a **Q/R Provider AE** SCP, generates responses to the **Move SCU** with status equal to Pending during the processing of the C-STORE sub-operations. These C-MOVE responses shall indicate the number of Remaining C-STORE sub-operations and the number of C-STORE sub-operations returning the status of Success, Warning, and Failed.

When the number of Remaining C-STORE sub-operations reaches zero, the **Q/R Provider AE** SCP must generate a final response with a status equal to Success, Warning, Failed or Refused. This response shall indicate the number of C-STORE sub-operations returning the status of Success, Warning, and Failed. If the status of a C-STORE sub-operation was Failed, a UID List must be returned.

3.4.1.1.2 C-MOVE-CANCEL Support

The PACS shall respond to a C-MOVE-CANCEL to terminate the C-MOVE Request. The SCU will recognize a response status of Canceled to indicate that the C-MOVE-CANCEL was successful.

3.4.1.1.3 Expected Response Codes

The RI **Q/R Provider AE** (C-MOVE) SCP response codes and error handling are according to the DICOM standard.

3.4.1.1.4 The Failed SOP Instance UID List

 The Failed SOP Instance UID List (0008,0058) specifies a list of UIDs of the C-STORE sub-operation SOP Instances for which the C-MOVE operation has failed. An Identifier in the C-MOVE response will contain the Failed SOP Instance UID List (0008,0058) for C-MOVE response status values of Canceled, Failure, Refused, or Warning. If no C-STORE sub-operation failed, the Failed SOP Instance UID List (0008,0058) is absent and therefore no Data Set will be sent in the C-MOVE response.

3.4.1.1.5 PACS Move Process Error Handling

The PACS shall detail its Query/Retrieve process flow on particular error conditions (DIMSE timeout on C-MOVE association while C-STORE associations in progress; PDU, TCP/IP level timeout for the same situation; Association aborted by IAQ Consumer **Move SCU**).

3.4.1.1.6 RI Move SCU Behavior on RI Move SCP Response Status

VistA Imaging's **Move SCU** will behave as described in table below; that is how the SCU AE responds to the Status Codes (0000,0900) returned in the C-MOVE response message.

Service Status	Further Meaning	Status Codes	Related Fields	C-MOVE SCU Behavior
Success	Matching is complete—no final identifier is supplied	0000	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	Remove items to be retrieved from internal action Item list
Refused	Out of Resources-cannot calculate number of matches	A701	(0000,0902)	Retrieval behavior terminated
	Out of resources-unable to perform sub-operations	A702	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	Retrieval behavior terminated
	Move destination unknown	A801	(0000,0902)	Retrieval behavior terminated
Failed	Identifier does not match SOP Class	A9xx	(0000,0901) (0000,0902)	Retrieval behavior terminated
	Unable to process	Cxxx	(0000,0901) (0000,0902)	Retrieval behavior terminated
Cancel	Sub-operations terminated due to Cancel Indication	FE00	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	Retrieval is terminated
Warning	Sub-operations complete - One or more failures	B000	(0000,1020) (0000,1022) (0000,1023)	Retrieval behavior terminated
Pending	Sub-operations are continuing	FF00	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	Keep listening for messages

Table 3-3: RI Provider – C-MOVE SCU Behavior on SCP Response Status

3.4.2 IOD Level Definitions

3.4.2.1 Message Attributes

The PACS RI Provider, as a **Q/R Provider AE** SCP Implementation shall comply with the C-MOVE DIMSE Service specified in the DICOM Standard (PS 3.4-2008, Annex C). The PACS **Q/R Provider AE** SCP shall be able to handle Study Root Study, Series and Composite-Object-Instance Level Hierarchical Move operations.

3.4.2.1.1 No Specific Character Set

Specific Character Set (0008,0005) shall not be present.

3.4.2.1.2 Supported Study Root Move Levels and Attributes

Study Root Study, Series and Composite Object Instance Level queries are generated. Relational searches are not supported yet but planned in the future. The following table describes the RI Consumer C-MOVE SCU Request attributes for the different level move requests following the Study Root Hierarchical Information Model:

Attribute	Tag	Study Level Move Value	Series Level Move Value	COI (Image) Level Move Value
Query/Retrieve Level	(0008,0052)	STUDY	SERIES	IMAGE
Study Instance UID	(0020,000D)	Unique value	Unique value	Unique value
Series Instance UID	(0020,000E)	Attribute omitted	1. Unique value , or 2. list of UIDs	Unique value
SOP Instance UID	(0008,0018)	Attribute omitted	Attribute omitted	1. Unique value, or 2. list of UIDs

Table 3-4: RI Provider – Supported Study Root Move Attributes

3.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert or above what is provided by the DICOM standard and/or recommended by IHE.

<Information may come as needed.>

4 PACS Storage User AE – Modality Images Stored (MIS) Consumer Profile

4.1 Use Case

IHE RAD TF-2: 4.8 (**Rad-8**) with different Actors:
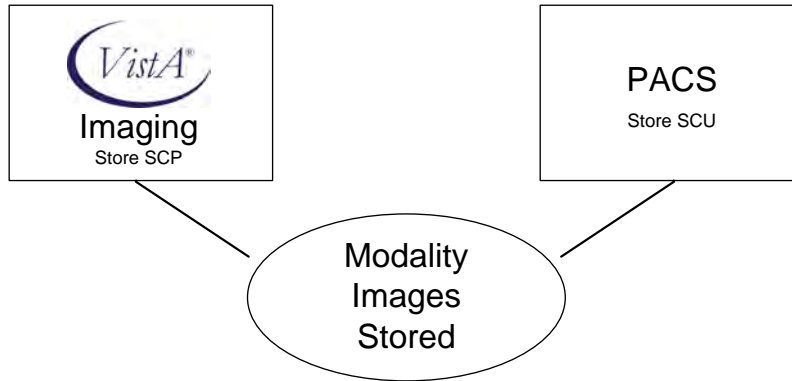
Actor: **VistA Imaging – Store SCP** (IHE Image Archive)

Role: Accept and store images (Composite Object Instances) from the PACS.

Actor: **PACS – Store SCU** (IHE "Acquisition Modality")

Role: Send PACS images (Composite Object Instances) to VistA Imaging.

4.2 Interactions

The actors in this use case shall perform the behaviors shown in the following sequence diagram.
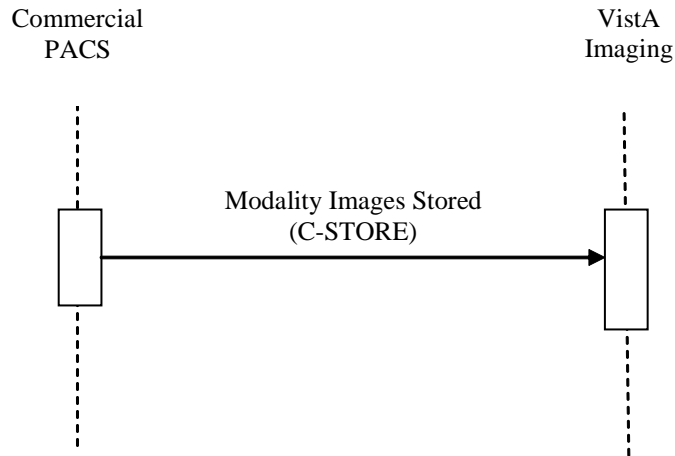
4.3 Dynamic Definition

VistA Imaging's **Store SCP** is a Storage Service Class Provider (SCP) AE that allows the PACS to send DICOM Composite Object Instances to VistA Imaging.

When the PACS **Q/R Provider AE** receives C-MOVE requests from VistA Imaging, it activates the **Storage User AE** (SCU) to send the relevant Composite Object Instances to VistA Imaging.

Another PACS may be configured to auto-route all available Object Instances to the VistA Imaging Storage Provider AE (**Store SCP**).

When the Composite Object Instances are received and accepted by the **Storage Provider AE**, they are incorporated into the VistA Imaging database and are permanently stored and subsequently archived.

4.3.1 Business Requirements

4.3.1.1   MIS Implementation

The VistA Imaging Instance Availability Notification (IAN) SCP (Chapter 1) is an AE that receives a DICOM IAN message from the PACS. This message tells VistA Imaging that specific DICOM Object Instances are available upon request. The IAN message contains information that enables VistA Imaging to examine if referenced Object Instances are stored or missing in the VistA database. For missing items, VistA Imaging will issue DICOM Study/MPPS Move requests to the PACS. The Move requests are issued via the VistA Imaging Retrieve Images (RI) Consumer's **Move SCU** to the PACS RI **Q/R Provider AE** SCP. The RI Provider Profile (Chapter 3) is applied. In this case the PACS **Q/R Provider AE** SCP uses the current MIS Provider profile to manage the delivery of all DICOM Object Instances of the given Study/MPPS from the PACS **Storage User AE** SCU to the VistA Imaging **Store SCP**.

If VistA Imaging does not receive a DICOM IAN message, it can still learn indirectly about DICOM Object Instances on the PACS. This is accomplished through receiving an HL7 "Exam Verified" message from the Radiology package (RIS) of the VistA System. This message contains the Patient Name/ID and the VistA Imaging Accession Number that are used in an Instance Availability Query (IAQ) issued to the PACS to obtain the Study UID. The Query request is issued via the VistA Imaging IAQ Consumer's **Find SCU** (Query User AE) to the PACS IAQ Provider's **Q/R Provider AE** SCP, applying the IAQ Provider Profile (Chapter 2). Subsequently, if referenced Object Instances are missing from the VistA Imaging database, just like in the previous case, the PACS **Q/R Provider AE** SCP (RI Provider Profile, Chapter 3) manages the delivery of all DICOM Object Instances of the given Study from the PACS MIS Consumer's **Storage User AE** SCU to the VistA Imaging MIS Provider's **Store SCP.**

Thus the PACS sends all its DICOM Object Instances to VistA Imaging.

4.3.1.2   Trigger Events

VistA Imaging receives an IAN message from the PACS or an HL7 "Exam Verified" message from the VistA database. In either case VistA Imaging will request transfer of images (Object Instances) of a Study or an MPPS from the PACS to VistA Imaging.

The PACS may also be configured to auto-route DICOM Object Instances to VistA Imaging.

4.3.1.3   PACS Simultaneous Stores

The PACS must declare the number of C-STOREs its MIS Consumer, as a **Storage User AE** SCU can perform simultaneously.

4.3.1.4   PACS Auto-Routing

It is recommended that the PACS automatically send all DICOM Object Instances to VistA Imaging as they become available.

4.3.1.5   PACS Move Object Serving Behavior

If PACS auto-routing is disabled, VistA Imaging will request DICOM Object Instance(s) of a Study/MPPS from the PACS by initiating a C-MOVE request to the PACS. Upon the reception of a VistA Imaging Move request, the PACS shall be able to initiate a DICOM connection and to transfer the requested DICOM Object Instance(s) to the VistA Imaging C-STORE SCP.

4.3.1.6   VistA Imaging MIS Provider Duplicate Instance Handling

Duplicate UIDs are the bane of DICOM. The VistA Imaging MIS Provider will check the UIDs of incoming Object Instances against the local VistA database and detect duplicates.   (However it cannot detect duplicates between different instantiations of VistA databases at this time, so duplicates may be created at different facilities.) Duplicate UID incidences will be acted upon in a proactive fashion in an attempt to curtail future occurrences.

The following table itemizes the VistA Imaging MIS Provider behavior in all combinations of duplicate instances.

     ✔ indicates that no duplicates have been found.

     ✘ indicates a duplicate was found in the VistA Imaging database.

     *   indicates either case.

Note: VistA Imaging reserves the right to modify these actions (response codes and content) in the future.

Issue ID#	Patient	Accession #	Study Inst. UID	Series Inst. UID	SOP Inst. UID	Context of Problem	Relative Occurrence	VistA Imaging MIS Provider Action
1	✔	✔	✔	✔	✔	n/a – normal case		Store object! (new instance)
2	✔	✔	✔	✔	✗	Duplicate SOP Instance UID at other Patient/Order/Study	H	Duplicate SOP instance UID found -- change incoming SOP Instance UID to newly generated one, Issue Warning with offending SOP Instance UID.
3	✔	✔	✔	✗	✔	Duplicate Series Instance UID at other Patient/Order/Study	L	Duplicate Series Instance UID -- change incoming Series Instance UID to newly generated one, Issue Warning with offending Series Instance UID.
4	✔	✔	✔	✗	✗	#2 & #3	L	Duplicate Series and SOP Instance UID -- change incoming Series and SOP Instance UIDs to newly generated ones, Issue Warning with offending Series Instance UID. (Not a realistic occurrence)
5	✔	✔	✗	✔	✔	Duplicate Study Instances UID at other Patient/Order	H	Duplicate Study instance UID -- change Study Instance UID to newly generated one. Issue Warning with offending Study Instance UID.
6	✔	✔	✗	✔	✗	#2 & #5	L	Duplicate Study and SOP Instance UID -- change incoming Study and SOP Instance UIDs to newly generated ones, Issue Warning with offending Study Instance UID.(Not a realistic occurrence)
7	✔	✔	✗	✗	✔	#3 & #5	L	Duplicate Study and Series Instance UID -- change incoming Study and Series Instance UIDs to newly generated ones, Issue Warning with offending Study Instance UIDs.(Not a realistic occurrence)
8	✔	✔	✗	✗	✗	#2, #3 & #5	L	Duplicate Study, Series and SOP Instance UID -- change incoming Study, Series and SOP Instance UIDs to newly generated ones, Issue Warning with offending Study Instance UID. (Very unlikely)
9 ..16	✔	✗	*	*	*	Same Acc# under different Patients (legitimate in DICOM world)		PACS system can have multiple Patients with same Acc#: VistA Imaging cannot resolve issue -- Issue Error with Reason: "Duplicate Accession Number at different Patients"
17	✗	✔	✔	✔	✔	n/a – normal case		Store object! (new order/study Instance at same patient)
18.. 24	✗	✔	*	*	*	Repeat #2..#8 under same Patient		Same issues – action like at #2..#8
25.. 28	✗	✗	✔	*	*	Sending DICOM system can have multiple Studies under one ACC# **(legitimate in DICOM world)**		PACS system can have multiple Studies under same Acc#: VistA Imaging cannot resolve issue -- Issue Error with Reason: "Multiple Studies with one Accession Number"
29	✗	✗	✗	✔	✔	n/a – normal case		Store object! (new Series & SOP Instance of existing Study)

Issue ID#	Patient	Accession #	Study Inst. UID	Series Inst. UID	SOP Inst. UID	Context of Problem	Relative Occurrence	VistA Imaging MIS Provider Action
30	✗	✗	✗	✔	✗	**#2** under same Study		Duplicate SOP instance UID found -- change incoming SOP Instance UID to newly generated one, Issue Warning with offending SOP Instance UID.
31	✗	✗	✗	✗	✔	n/a – normal case		Store object! (new SOP Instance of existing series)
32	✗	✗	✗	✗	✗	Resend detected	H	Resend – return Success, instance not stored!

Table 4-1: MIS Consumer – MIS Provider Duplicate Instance Handling Matrix

Notes: 1. Warning messages, listed above, carry offending tag and Instance UID
2. Error messages, listed above, carry only textual error reason.
3. More information sharing might be arranged using other delivery mechanisms.

4.3.1.7 No User Characteristics

The MIS (Store) Consumer Profile implements a system-to-system interface. No User Characteristics are defined or assumed.

4.3.2 Error Handling

4.3.2.1 Confirm PACS MIS Store Request Message

Verify that the PACS MIS **Storage User AE** (C-STORE) SCU request meets the DICOM standard and IHE profile definitions.

4.3.2.2 Return Store Rejected Response Message to the PACS

The purpose of this test is to determine what the PACS does in such use case.

4.3.3 Functional Requirements

4.3.3.1 MIS Store SCU

The PACS MIS Consumer, as a **Storage User AE** SCU implementation shall act as a C-STORE DIMSE Service Class User (SCU) that can send all the SOP Classes listed with assigned Transfer Syntaxes in Table 0-5.

4.3.3.2 Persistent Storage of DICOM Object Instances

VistA Imaging will only store the received DICOM Object Instance after it has validated the DICOM content. In case of a failure, an error message will be sent to the PACS **Storage User AE** SCU, indicating that storage of the item was rejected. In case of success all received attributes are stored persistently to assure sender's ability to retrieve

each Object Instance as it was sent. Private Elements in the DICOM dataset are not used or interpreted by VistA Imaging.

4.4 DICOM-Specific Definitions

4.4.1 SOP Level Definitions

The PACS MIS Consumer, as a **Storage User AE** SCU shall support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Storage Provider AE	Verification SOP Class	SCU	Verification (DICOM Echo)
	Various Storage SOP Classes listed in Table 0-5	SCU	Storage of DICOM Object Instances

Table 4-2: MIS Consumer – SOP Classes

See Table 0-5 in the introduction section for various VistA Imaging **Store SCP** Supported SOP classes.

4.4.1.1 Association Establishment Policies

4.4.1.1.1 General

The VistA Imaging MIS **Store SCP** accepts but never initiates connections. The maximum PDU size offered by the MIS **Store SCP** is 32768 bytes by default but can be altered later during association negotiation. SOP Class Extended Negotiation is not supported.

The DICOM standard Application Context (1.2.840.10008.3.1.1.1) will be specified.

The VistA Imaging MIS Provider, as a **Store SCP,** offers no specialization for any of the supported SOP classes.

Multiple storage requests may be handled during an Association in a sequential fashion.

The Association must persist for the duration of each request. There is no set upper time limit between requests. If the Association is closed before a request has been completed, the outcome of the request is indeterminate.

4.4.1.1.2 Number of Simultaneous Associations

The VistA Imaging **Store SCP** can handle multiple associations. The maximum number of simultaneous associations the MIS **Store SCP** will maintain is limited only by system (mainly memory and processor) resources.

4.4.1.2 Association Acceptance Policy

The MIS Consumer, as a **Storage User AE** SCU, shall not accept associations.

4.4.1.3 MIS Store SOP Specific Conformance

4.4.1.3.1 No Priority Handling by C-STORE SCP

The value of the C-STORE priority attribute is ignored by the VistA Imaging **Store SCP**.

4.4.1.3.2 MIS C-STORE SCP Transfer Syntax Selection

In its default configuration, the VistA Imaging **Store SCP** will always select Explicit VR Little Endian if it is one of several transfer syntaxes that are offered in a single Presentation Context. The VistA Imaging **Store SCP** will accept another supported transfer syntax (for example, Implicit VR Little Endian) if it is the only one offered in a Presentation Context.

The PACS **Storage User AE** SCU shall offer the original transfer syntax of the DICOM Object Instance in a Presentation Context and offer the default Explicit VR Little Endian transfer syntax in a second Presentation Context. The PACS **Storage User AE** SCU shall use first Presentation Context if it is accepted.

4.4.1.3.3 MIS Store SCP behavior on Response Codes

The VistA Imaging MIS **Store SCP** behaves as described below in response to a C-STORE command.

Service Status	Further Meaning	Status Codes (0000,0900)	Related Fields	C-STORE SCP Behavior
Success		0000		Data Set stored
Refused	Out of Resources	A7xx	(0000,0902)	Out of memory or disk space
Error	Data Set does not match SOP Class	A9xx	(0000,0901) (0000,0902)	Data Set Not stored – return offending SOP Class
	Cannot understand	Cxxx	(0000,0901) (0000,0902)	Data Set Not stored – return offending element with reason
Warning	Coercion of Data Elements	B000	(0000,0901) (0000,0902)	Details sent – for duplicate UID, offending UID returned; for coercion list of tags touched
	Data Set does not match SOP Class	B007	(0000,0901) (0000,0902)	Never sent
	Elements Discarded	B006	(0000,0901) (0000,0902)	Never sent – all elements are always stored

Table 4-3: MIS Consumer – C-STORE SCP Response Status and Behavior

4.4.2 IOD Level Definitions

4.4.2.1 No Elements discarded on successful Store SCP Operation

VistA Imaging preserves all tags in received SOP instances according to Level 2 (full) storage requirements. VistA Imaging only updates existing attributes or adds them if they would be missing. See VistA Imaging Data Coercion entry.

4.4.2.2 VistA Imaging Data Coercion

The VistA database, as the system of record, maintains the latest information for all aspects of medical care. When the **Store SCP** serves Object Instances, key DICOM tag values are updated just before **Store SCP** sends the data. The following table gives a list of tags that might be affected in case a change occurred in the VistA database after the Object was stored.

Description	Tag
Study Date	(0008,0020)
Accession Number	(0008,0050)
Modality	(0008,0060)
Referring Physician's Name	(0008,0090)
Study Description	(0008,1030)
Performing Physician's Name	(0008,1050)
Patient Name	(0010,0010)
Patient ID	(0010,0020)
Patient Birth Date	(0010,0030)
Patient Birth Time	(0010,0032)
Patient Sex	(0010,0040)
Other Patient IDs	(0010,1000)
Patient Address	(0010,1040)
Medical Alerts	(0010,2000)
Ethnic Group	(0010,2160)
Requesting Physician	(0032,1032)
Requesting Service	(0032,1033)
Requested Procedure Description	(0032,1060)
Current Patient Location	(0038,0300)

Table 4-4: MIS Consumer – DICOM Elements Subject to Data Coercion[3]

Note: Need for Coercion affects only a small portion of the cases. It is most probable the older Studies have obsolete data in the archived Object Instances and the VistA database coerces those fields with recent data. The PACS probably received HL7 updates at the time of the change for most of these fields so when the Store SCP delivers this objects

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[3] VistA Imaging might alter this list for the final version of this document to take in account vendor comments and the final VistA Imaging implementation.

with the updated fields in the DICOM header of the outgoing data, the PACS database might not need any adjustment.

The PACS **Storage User AE** shall be able to reconcile applicable changes in its database.

4.4.2.3 Lossy Image Compression Attribute Policies

The Lossy Image Compression (0028,2110) attribute (with value '01') must be present in the IOD if lossy compression applied on the pixel data. In this case the Lossy Compression Ratio (0028,2112) and Lossy Image Compression Method (0028,2114) attributes must be present and filled according to the DICOM standard.[4]

If lossless compression or no compression applied, the Lossy Image Compression (0028,2110) attribute with value '00' may be present in the IOD but not required.

4.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert or above what is provided by the DICOM standard and/or recommended by IHE.

<Information may come as needed.>

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[4] Lossy Compression Ratio (0028,2112) has VR=DS and Lossy Image Compression Method (0028,2114) has VR=CS. Both have value multiplicity VM=1-n.

5 PACS Storage Commit User AE – Storage Commitment (SC) Consumer Profile

5.1 Use Case

IHE RAD TF-2: 4.10 (**Rad-10**) with different Actors:
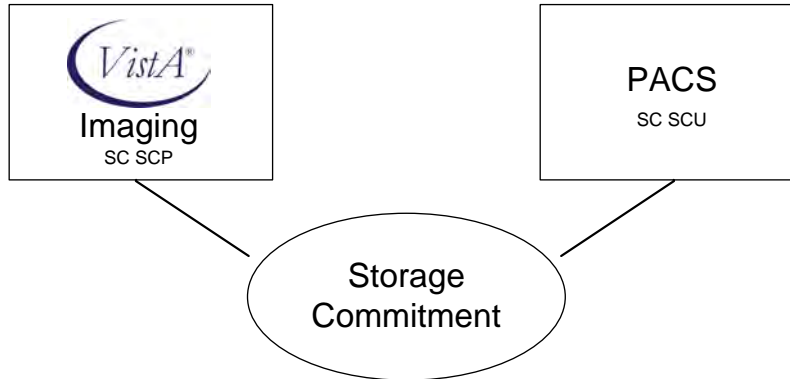
Actor: **VistA Imaging – SC SCP** (IHE Image Manager)

Role: Assume responsibility for reliable storage, retrieval, and validity of Composite Object Instances archived earlier.

Actor: **PACS – SC SCU** (IHE Evidence Creator)

Role: Make requests for storage commitment of Composite Object Instances previously transmitted to VistA Imaging.

5.2 Interactions

The actors in this use case shall perform the behaviors shown in the following sequence diagram.
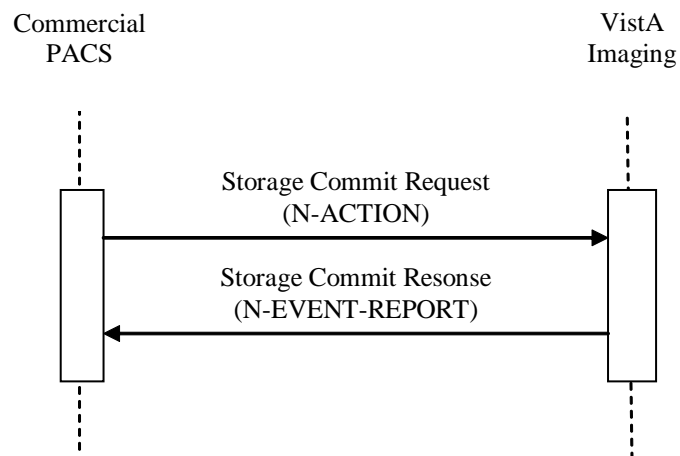
5.3 Dynamic Definition

The Storage Commitment (SC) Consumer Profile allows the PACS to confirm that VistA Imaging explicitly takes responsibility for the safekeeping of previously transferred data.

VistA Imaging's **Storage Commit SCP** is a Storage Commitment Service Class Provider (SCP) that allows the PACS to send Storage Commit transaction requests to VistA Imaging. When the **Storage Commit SCP** processes a request, it will check the VistA Imaging database to see that each Object Instance is stored permanently and then inform the PACS **Storage Commit User AE** SCU of its findings.

The VistA Imaging **Storage Commit SCP** response is delivered using a different DICOM association than that used by the PACS **Storage Commit User AE** SCU. Consequently, DICOM reverse role negotiation must be performed between the PACS **Storage Commit User AE** SCU and the VistA Imaging **Storage Commit SCP.** Once a connection is established, the VistA Imaging **Storage Commit SCP** initiated N-EVENT REPORT will be delivered to the PACS **Storage Commit User AE** SCU.

5.3.1 Business Requirements

5.3.1.1 SC Implementation

With Storage Commitment, the PACS can be assured that VistA Imaging provides long-term storage of all SOP Instances that were successfully sent to it. Once the VistA Imaging **Storage Commit SCP** informs the PACS **Storage Commit User AE** SCU that it has accepted the responsibility to store the SOP Instances in scope, the PACS is free to delete its copies of those SOP Instances.

The SC response messages define the **Move SCP** AE from which items can be retrieved. (The VistA Imaging **Storage Commit SCP** is not the AE from which such SOP Instances can later be retrieved.)

5.3.1.2 Trigger Events

When the PACS is running out of storage space, it needs to remove older items from its on-line storage space to make room for new ones. Before an item can be removed, however, the PACS must be assured that the item has been safely archived. This is the point where the PACS issues a Storage Commitment request to VistA Imaging, the official archive.

5.3.1.3 PACS Simultaneous Commitment Requests

The PACS must declare the number of storage commitments its **Storage Commit User AE** SCU can perform simultaneously (each on its own association).

5.3.1.4 Restore AE Title

For SOP Instances found in the VistA Imaging database, the VistA Imaging **Storage Commit SCP** will return the AE title of the VistA Imaging RI Provider's **Q/R Provider AE** (Move) SCP as the peer to be contacted by the PACS for SOP Instance retrievals.

5.3.1.5 Storage Commitment Session Duration

VistA Imaging will respond to every Storage Commitment Request as soon as the referenced items in the request can be identified and their storage status can be determined. The **Storage Commit User AE** SCU will receive a response (success or results with failures) within 48 hours. After that time the PACS should not expect to receive a meaningful response, therefore, in this rare scenario, the **Storage Commit User AE** SCU should issue a new request for the uncommitted SOP Instances.

5.3.1.6 No User Characteristics

The **Storage Commit** Consumer Profile implements a system-to-system interface. No User Characteristics are defined or assumed.

5.3.2 Error Handling

5.3.2.1 Confirm PACS SC Request Message

Verify that the PACS **Storage Commit User AE** (N-ACTION) SCU request meets the DICOM standard and IHE profile definitions.

5.3.2.2 Return Reject Response Message to the PACS

To determine what the PACS does in such use case.

5.3.3 Functional Requirements

5.3.3.1 Storage Commit User AE SCU Request

The PACS **Storage Commit User AE** SCU implementation shall act as an N-ACTION DIMSE Service Class User (SCU) that shall be able to support association Reverse Role Negotiation and shall be able to send a Storage Commitment Push Model SOP Class message conforming to the DICOM standard. The PACS **Storage Commit User AE** SCU should expect a Storage Commitment N-EVENT-REPORT from the VistA Imaging **Storage Commit SCP** using a different association than the **Storage Commit User AE** SCU established.

5.3.3.2 Storage Commit SCP Response

The VistA Imaging **Storage Commit SCP** will establish association to the PACS **Storage Commit User AE** SCU using reverse role negotiation to be able to deliver a Storage Commitment N-EVENT-REPORT response to an N-ACTION request previously received through another association. The PACS **Storage Commit User AE** SCU shall be able to receive and accept the reverse role case.

5.4 DICOM-Specific Definitions

5.4.1 SOP Level Definitions

The PACS **Storage Commit User AE** SCU shall support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Commit AE	Verification SOP Class	SCU	Verification (DICOM Echo)
	Storage Commitment	SCU/SCP	Commitment of DICOM Object Instances

Table 5-1: SC Consumer – SOP Classes

Note: The **Storage Commit User AE** SCU shall support association reversed role negotiation in order to receive N-EVENT-REPORT messages from the VistA Imaging **Storage Commit SCP**.

See N-EVENT-REPORT Failure Response Codes under IOD Level Definitions.

5.4.1.1 Association Establishment Policies

5.4.1.1.1 General

The VistA Imaging **Storage Commit SCP** accepts and initiates connections. The maximum PDU size offered by the SC SCP is 32768 bytes by default but can be altered later during association negotiation. SOP Class Extended Negotiation is not supported. Reversed Role negotiation is a must for both the **Storage Commit User AE** SCU and the **Storage Commit SCP**.

The DICOM standard Application Context (1.2.840.10008.3.1.1.1) will be specified.

5.4.1.1.2 Number of Simultaneous Associations

The VistA Imaging **Storage Commit SCP** can handle multiple associations. The maximum number of simultaneous associations the **Storage Commit SCP** will maintain is limited only by system (mainly memory and processor) resources.

5.4.1.2 Association Acceptance Policy

The PACS **Storage Commit User AE** SCU shall accept reversed role negotiation association requests from the **Storage Commit SCP**.

5.4.2 IOD Level Definitions

5.4.2.1   Commonly Used SC Message Attributes

5.4.2.1.1   Transaction UID

The PACS **Storage Commit User AE** SCU shall generate a transaction UID for each SC Request (N-ACTION) message and shall remember that UID as long as the relevant SC response is collected from the **Storage Commit SCP** with the same Transaction UID or until the response collection Duration timeout period expired. After either of above events occurs, the Transaction UID is no longer active and shall not be reused for other transactions.

5.4.2.1.2   SOP Class of Referenced SOP Instances

See Table 0-5 in the introduction section for VistA Imaging **Storage Commit SCP** Supported SOP classes that can be referenced in an **Storage Commit User AE** SCU N-ACTION and **Storage Commit SCP** N-EVENT-REPORT message.

5.4.2.2   SC SCU N-ACTION (Request) Message

The following table describes the **Storage Commit User AE** SCU N-ACTION Request and the use of each attribute by the VistA Imaging **Storage Commit SCP**:

Attribute Description	Tag	SCU Type	SC SCP Usage Notes
Transaction UID	(0008,1195)	1	Unique identifier for each message, generated by SCU, used by SCP in response
Storage Media File Set ID	(0088,0130)	3	Ignored
Storage Media File Set UID	(0088,0140)	3	Ignored
Referenced SOP Sequence	(0008,1199)	1	Processed
> Referenced SOP Class UID	(0008,1150)	1	Validated against Table 0-5 and stored
> Referenced SOP Instance UID	(0008,1155)	1	Stored for response processing
> Storage Media File Set ID	(0088,0130)	3	Ignored
> Storage Media File Set UID	(0088,0140)	3	Ignored

Table 5-2: SC Consumer – Storage Commitment N-ACTION Request Attributes

5.4.2.3   Successful SC SCP N-EVENT-REPORT (Response) Message

The following table describes the successful (event type = 1) **Storage Commit SCP** N-EVENT-REPORT (Response) message and the setting of each attribute by VistA Imaging **Storage Commit SCP**:

Attribute Description	Tag	SCP Type	SC SCP Usage Notes
Transaction UID	(0008,1195)	1	UID from corresponding SC SCU request
Retrieve AE Title	(0008,0054)	3	Always set to Move SCP AE

Attribute Description	Tag	SCP Type	SC SCP Usage Notes
Storage Media File Set ID	(0088,0130)	3	Zero length, no value
Storage Media File Set UID	(0088,0140)	3	Zero length, no value
Referenced SOP Sequence	(0008,1199)	1	Processed
> Referenced SOP Class UID	(0008,1150)	1	Set from request element
> Referenced SOP Instance UID	(0008,1155)	1	Set from request element
> Retrieve AE Title	(0008,0054)	3	Zero length, no value
> Storage Media File Set ID	(0088,0130)	3	Zero length, no value
> Storage Media File Set UID	(0088,0140)	3	Zero length, no value

Table 5-3: SC Consumer – Successful N-EVENT-REPORT Response Attributes

5.4.2.4 Complete with Failures SC SCP N-EVENT-REPORT (Response) Message

The following table describes the Request Complete with Failures (event type = 2)
Storage Commit SCP N-EVENT-REPORT (Response) message and the setting of each
attribute by VistA Imaging **Storage Commit SCP**:

Attribute Description	Tag	SCP Type	SC SCP Usage Notes
Transaction UID	(0008,1195)	1	UID from corresponding SC SCU request
Retrieve AE Title	(0008,0054)	3	Always set to Move SCP AE
Storage Media File Set ID	(0088,0130)	3	Zero length, no value
Storage Media File Set UID	(0088,0140)	3	Zero length, no value
Referenced SOP Sequence	(0008,1199)	1C	Processed. Not present on 0 successes
> Referenced SOP Class UID	(0008,1150)	1	Set from request element
> Referenced SOP Instance UID	(0008,1155)	1	Set from request element
> Retrieve AE Title	(0008,0054)	3	Zero length, no value
> Storage Media File Set ID	(0088,0130)	3	Zero length, no value
> Storage Media File Set UID	(0088,0140)	3	Zero length, no value
Failed SOP Sequence	(0008,1198)	1	Processed. Always present
> Referenced SOP Class UID	(0008,1150)	1	Set from request element
> Referenced SOP Instance UID	(0008,1155)	1	Set from request element
> Failure Reason	(0008,1197)	1	Failure Code

Table 5-4: SC Consumer – Complete /w Failures N-EVENT-REPORT Response Attributes

5.4.2.5 SC SCP Failure Reasons

The following table lists the possible Failure Reason Codes, their meaning and short description for the Complete with Failures response cases:

Code	Meaning	Description
0110H	Processing Failure	A general failure in processing the operation was encountered.
0112H	Resource Limitation	The SCP does not currently have enough resources to store the requested SOP Instance(s).
0112H	No Such SOP Instance	One or more of the elements in the Referenced SOP Instance Sequence were not available.
0213H	Resource Limitation	The SCP does not currently have enough resources to store the requested SOP Instance(s).
0122H	Referenced SOP Class Not Supported	Storage Commitment has been requested for a SOP Instance with a SOP Class that is not supported by the SCP.
0119H	Class / SOP Instance Conflict	The SOP Class of an element in the Referenced SOP Instance Sequence did not correspond to the SOP class registered for this SOP Instance at the SCP.
0131H	Duplicate transaction UID	The Transaction UID of the Storage Commitment Request is already in use.

Table 5-5: SC Consumer – Storage Commitment Failure Reason Codes

5.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert or above what is provided by the DICOM standard and/or recommended by IHE.

<Information may come as needed.>

6 PACS Query/Retrieve User AE – Query Images (QI) Consumer Profile

6.1 Use Case

IHE RAD TF-2: 4.14 (**Rad-14**) with different Actors:
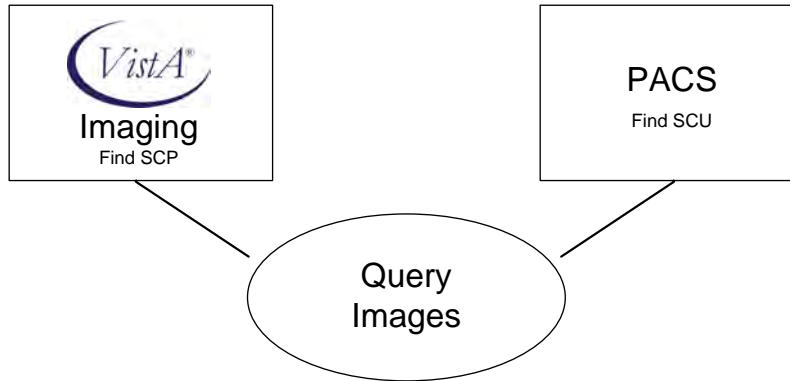
Actor: **VistA Imaging – Find SCP** (IHE Image Archive)

Role: Respond to PACS Query Images request with Composite Object Instance (image) Level details.

Actor: **PACS – Find SCU** (IHE Image Display)

Role: Issue Query Images request to VistA Imaging for finding details on an archived Study, Series or a list of Composite Object Instances (images).

6.2 Interactions

The actors in this use case shall perform the behaviors shown in the following activity diagram.
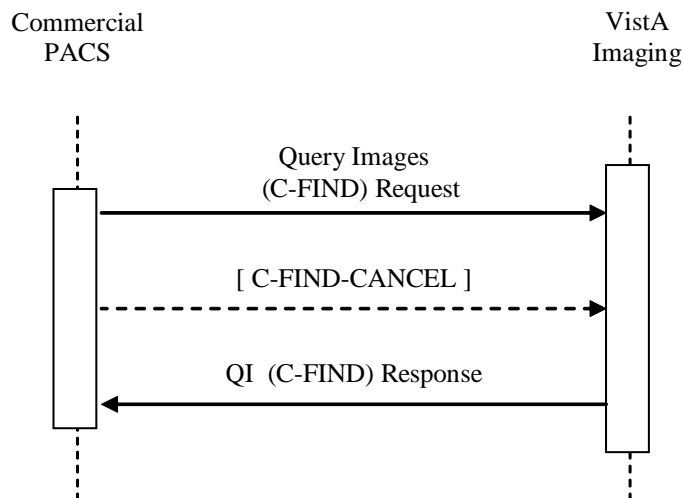
6.3 Dynamic Definition

VistA Imaging is the (Level 2) image archive at each VistA site. After the local PACS system archives studies in VistA Imaging, the PACS can retrieve all or parts of them using DICOM Query/Retrieve.

The PACS **Q/R User AE** (C-FIND) SCU issues the Query Images (QI) request, as a QI Consumer, to VistA Imaging's **Query** (C-FIND) **SCP** to receive information on Composite Object Instances of a designated patient's archived Study, Series or selected itemized list of Instances A successful query by the PACS is usually followed by a PACS **Q/R User AE** (C-MOVE) SCU request that initiates the retrieval of Composite Object Instance(s) through VistA Imaging's MIS **Store SCU** (C-STORE SCU). The VistA Imaging **Move SCP** activates VistA Imaging's MIS **Store SCU** (C-STORE SCU) to send all relevant images to the PACS's MIS **Store Provider AE** (C-STORE) SCP.

VistA Imaging's **Find SCP** is a Study Root Query/Retrieve Information Model – FIND Service Class Provider (SCP) that allows the PACS to query VistA Imaging for information about Composite Object Instances of a Study of a patient. The **Find SCP** accepts Study Root Study, Series, and Composite Object Instance (image) Level C-FIND requests from the PACS QI **Q/R User AE** SCU and returns information about the VistA Imaging archived Composite Object Instances that belong to the designated Patient/Study. The **Find SCP** AE can also serve Study Root Study, Series and Composite Object Instance (image) Level C-MOVE requests to serve Composite Object Instances of a designated group from the VistA Imaging archive.

6.3.1 Business Requirements

6.3.1.1   The QI Implementation

Once Studies archived by VistA Imaging, the PACS can issue DICOM Study, Series, and Composite Object Instance (image) Level query requests to VistA Imaging to gather information that supports subsequent retrieval of all Composite Object Instances of that designated group. The Study level PACS Query can refer to the Study by the patient's name and/or ID and the VistA Imaging Accession Number or just simply by the Study Instance UID. Series and Object Instance levels PACS Queries must use the relevant Instance UIDs.

6.3.1.2   PACS Trigger Event

The PACS wishes to retrieve an archived Study's, Series' or a select group's images (Composite Object Instances).

6.3.1.3   Simultaneous Queries

The number of simultaneous queries the VistA Imaging Query Provider AE can support is limited by system resources only. The PACS must declare the number of queries its QI Consumer, as a **Q/R User AE** SCU can perform simultaneously.

6.3.1.4 Priority Processing

The current VistA Imaging **Find SCP** does not support priority processing. Later versions might implement it upon need. For future interoperations, the PACS shall declare if it does support priority requests.

6.3.1.5 Response Message Limitations

VistA Imaging does limit the maximum number of Query Response messages during a C-FIND operation, but the value is site configurable. The default setting is 500 items. When this limit is reached but more items left an "out of resource" failure status (A700h) is returned.

6.3.1.6 Retrieve AE Title Specifics

VistA Imaging can respond to Move Requests from and delivering DICOM Object Instances to an AE other than the PACS **Q/R User AE**.

6.3.1.7 No User Characteristics

The QI Consumer Profile implements a system-to-system interface. No User Characteristics are defined or assumed.

6.3.2 Error Handling

6.3.2.1 Confirm Response Handling of the PACS QI Find SCU

Verify that the QI **Q/R User AE** SCU handles correctly and incorrectly formed C-FIND responses based on the DICOM standard and the IHE profile definitions.

6.3.3 Functional Requirements

6.3.3.1 QI Find SCU

The PACS QI implementation shall act as a Study Root Query/Retrieve Information Model -- FIND Service Class User (SCU). The PACS **Q/R User AE** SCU shall issue only Study Root Study, Series and Composite Object Instance (Image) Level Query requests to the VistA Imaging **Find SCP**.

6.3.3.2 Expected QI Action

VistA Imaging (IHE Image Archive) QI **Find SCP** responds to the SCU's C-FIND Request as specified in the DICOM standard, including returning the SOP Instance UIDs (0008,0018) and corresponding Retrieve (Move) AE title (0008, 0054) when a match is successful.

6.3.3.3 Presentation Context

The table below lists the proposed presentation context for the PACS's **Q/R User AE** that is anticipated by VistA Imaging as a **Find SCP**:

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
Name	**UID**	**Name List**	**UID List**		
Study Root Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.2.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

<div align="center">**Table 6-1: QI Consumer – Presentation Context**</div>

The PACS shall support the Study Root Query/Retrieve Information Model – FIND SOP class as a **Q/R User AE SCU**, using the listed transfer syntax in the table above.

6.3.3.4   Request Message

The PACS shall issue a Study Level Query Request message by specifying the Patient Name and/or ID along with an Accession number as required keys and defining either:

> Case A: the Study Instance UID as a zero length unique value for Study UID search

> Case B: the Study instance UID as a unique key for single-value match

In both cases the Query/Retrieve Level (0008,0052) required field is "STUDY".

Notes:

- A Case A Query is required only if the PACS wants to learn the Study Instance UID in order to be able to issue subsequent Study, Series, and optionally Composite Object Instance Level Find or Move operations

- A Case B Query is required only when the PACS knows the Study Instance UID but would like to get more Study level information before issuing the Study Level Move request.

Series and Instance Level queries shall be issued by specifying the parent Instance Level UIDs as required key(s) with unique value(s) for single value matching. The selected level Instance UID as a zero length value for Instance UID search or Unique UID value for single value Match on the query level.

6.4 DICOM-Specific Definitions

6.4.1 SOP Level Definitions

The PACS QI **Q/R User AE** SCU should support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Q/R User AE	Verification SOP Class	SCU	Verification (DICOM Echo)

Application Entity	SOP Class	Role	Real-World Activity
	Study Root Query/Retrieve Information Model – FIND	SCU	Query VistA Imaging for information about the Patient, Study, Series and Instances (Study, Series and Composite-Object-Instance Level)

<div align="center">

Table 6-2: QI Consumer – SOP Classes

</div>

6.4.1.1 Association Establishment Policies

6.4.1.1.1 General

The maximum PDU size offered by the current **Find SCP** is 32768 bytes by default but can be altered during association negotiation. SOP Class Extended Negotiation is not supported. Negotiation of combined date-time matching and fuzzy semantic matching of person names is not supported.

The DICOM standard Application Context (1.2.840.10008.3.1.1.1) shall be specified.

6.4.1.1.2 Number of Simultaneous Associations

The maximum number of simultaneous associations the VistA Imaging QI Provider, as a **Find** SCP will maintain is only limited by resources. The **Q/R User AE** SCU shall not expect response for more than defined number of simultaneous associations from the **Find SCP**.

6.4.1.2 Association Acceptance Policy

The QI Consumer, as a **Q/R User AE** SCU, does not need to accept associations.

6.4.1.3 Association Rejection

The VistA Imaging **Find SCP** may reject Association attempts as shown in the table below. The Result, Source, and Reason/Diagnostics columns represent the values returned in the corresponding fields of an ASSOCIATE-RJ PDU (see PS3.8-2008, Section 9.3.4).

Result	Source	Reason/Diag.	Explanation
1 – rejected-permanent	1 – DICOM UL service-user	2 – application-context-name-not-supported	The Association request contained an unsupported Application Context Name. An association request with the same parameters will not succeed at a later time.
1 – rejected-permanent	1 – DICOM UL service-user	3 – calling-AE-title-not-recognized	The Association request contained an unrecognized Calling AE Title. An Association request with the same parameters will not succeed at a later time unless configuration changes are made. This rejection reason normally occurs when the Association acceptor has not been configured to recognize the AE Title of the Association initiator.

Result	Source	Reason/Diag.	Explanation
1 – rejected-permanent	1 – DICOM UL service-user	7 – called-AE-title-not-recognized	The Association request contained an unrecognized Called AE Title. An Association request with the same parameters will not succeed at a later time unless configuration changes are made. This rejection reason normally occurs when the Association initiator is incorrectly configured and attempts to address the Association acceptor using the wrong AE Title.
1 – rejected-permanent	2 – DICOM UL service-provider (ASCE-related function)	1 – no-reason-given	The Association request could not be parsed. An Association request with the same format will not succeed at a later time.
2 – rejected-transient	3 – DICOM UL service-provider (Presentation-related function)	1 – temporary-congestion	No Associations can be accepted at this time due to the real-time requirements of higher priority activities (e.g. during image acquisition no Associations will be accepted) or because insufficient resources are available (e.g. memory, processes, threads). An Association request with the same parameters may succeed at a later time.
2 – rejected-transient	3 – DICOM UL service-provider (Presentation-related function)	2 – local-limit-exceeded	Never happens -- The (configurable) maximum number of simultaneous Associations has been reached. An Association request with the same parameters may succeed at a later time.

Table 6-3: QI Consumer – VistA Imaging C-FIND SCP Association Rejection Reasons

6.4.1.4   QI Query SOP Specific Conformance

6.4.1.4.1 Study Root Query/Retrieve Information Model - FIND SOP Class

The SOP Class conforms to the basic requirements set forth by the DICOM standard. All return keys are included in the C-FIND request.

6.4.1.4.2 Expected QI Find SCP Behavior

The VistA Imaging **Find SCP** performs a match on all the keys specified in the Identifier of the request, against the information it possesses, to the level specified in the request. Attribute matching is performed using the key values specified in the Identifier of the C-FIND request as defined in Section PS3.4.C.2 of the DICOM (2008) standard.

The VistA Imaging **Find SCP** generates a C-FIND response for each entity that matches the Identifier in the request. All such responses contain an Identifier whose Attributes contain values from a single match. All such responses contain a status of Pending.

When all matches have been sent, the VistA Imaging QI **Find SCP** generates a C-FIND response which contains a status of Success. A status of Success indicates that a response has been sent for each match known to the SCP.

> Note: When there are no matches, then no responses with a status of Pending is sent, only a single response with a status of Success.

The VistA Imaging QI **Find SCP** generates a response with a status of Refused or Failed if it is unable to process the request. A Refused or Failed response contains no Identifier.

6.4.1.4.3 Expected QI Find SCU Behavior

The returned patient and procedure information that is supplied by VistA Imaging is from the master patient record database. The PACS might have different patient information on file, so it is recommended that the PACS uses the just-queried information and then information from the subsequently received instances to ensure that the most recent patient data from the VistA Imaging Image Archive is used/displayed.

6.4.1.4.4 QI Find SCP Responses Sent to QI Find SCU

The table below lists the VistA Imaging QI **Find SCP** responses sent to the PACS QI Consumer, the **Q/R User AE** SCU and notes the relevant SCP behavior.

Service Status	Further Meaning	Status Code (0000,0900)	Related Fields	C-FIND SCP Behavior
Success	Success	0000	None	Matching is complete. No final identifier is supplied.
Refused (Failed)	Out of Resources	A700	(0000,0902)	System reached the limit in disk space or memory usage or number of items retuned. Error message is output, as an alert, to VistA Imaging maintenance personnel, and to the Service Log.
Failed	Identifier does not match SOP Class	A900	(0000,0901) (0000,0902)	The C-FIND query identifier contains invalid Elements or values, or is missing mandatory Elements or values for the specified SOP Class. Error message is output to the Service Log.
	Unable to process	C001	(0000,0901) (0000,0902)	The C-FIND query identifier is valid for the specified SOP Class but cannot be used to query the database. For example, this can occur if a Patient Level query is issued but the identifier has only empty values for both the Patient ID and the Patient Name. Error message is output to the Service Log.
Cancel	Matching terminated due to Cancel Request	FE00	None	The C-FIND SCU sent a Cancel Request. This has been acknowledged and the search for matches has been halted.
Pending	Matches are continuing and current match is supplied.	FF00	Identifier	Indicates that the search for further matches is continuing. This is returned when each successful match is returned and when further matches are forthcoming. This status code is returned if all Optional keys in the query identifier are actually supported.
	Matches are continuing but one or more Optional Keys were not supported.	FF01	Identifier	Indicates that the search for further matches is continuing. This is returned when each successful match is returned and when further matches are forthcoming. This status code is returned if there are Optional keys in the query identifier that are not supported.

Table 6-4: QI Consumer -- Behavior on VistA Imaging C-FIND SCP Response Status

6.4.1.4.5 *Retrieve AE Title*

Per the DICOM standard, Retrieve AE Title (0008,0054) is supported and returned by the Image Manager (i.e. VistA Imaging **Move SCP**) as part of the response.

6.4.1.4.6 *Storage Media File-Set Attributes*

Storage Media File-Set ID (0088,0130) and Storage Media File-Set UID (0088,0140) are not used by VistA Imaging.

6.4.1.4.7 *Instance Availability Option*

To better quantify Access Time, the optional attribute Instance Availability (0008,0056) with enumerated values of "ONLINE", "NEARLINE" and "OFFLINE" can be requested. In terms of access times and results of subsequent Retrieve (C-MOVE) requests, the Image Availability values for VistA Imaging shall be interpreted as follows:

Level	Description	Access time
ONLINE	Images can be retrieved from storage location and be ready for distribution within a reasonable period of time (what time is reasonable is implementation-specific)	Seconds to a minute
NEARLINE	Before distribution, images has to be processed/staged at a storage location; total retrieval time is longer than "reasonable"	Minute to an hour
OFFLINE	Image cannot be distributed without human user intervention	Minutes to Hours to days

Table 6-5: QI Consumer – VistA Imaging Composite Object Instance Access Times

An empty Instance Availability field shall be taken as ONLINE.

6.4.1.4.8 *C-FIND-CANCEL Support*

The VistA Imaging **Find SCP** supports the C-FIND-CANCEL request to terminate an in-progress C-FIND Request. The **Q/R User AE** SCU, once issued a C-FIND-CANCEL, shall recognize a response status of Canceled that indicates that the C-FIND-CANCEL was successful. The **Find SCP** will stop generating and returning response entries.

6.4.2 IOD Level Definitions

6.4.2.1 Message Attributes

The PACS **Q/R User AE** SCU Implementation shall comply with the C-FIND DIMSE Service specified in the DICOM Standard (PS 3.4-2008, Annex C). The PACS **Find SCP** conforms to the DICOM standard as a Study Root Study, Series, and Composite-Object-Instance Level C-MOVE SCP with the following stipulations.

6.4.2.1.1 *Default Character Set Support*

The QI **Find SCP** expects the use of the default character set of ISO-IR 6 when receiving and decoding queries and performs the same encoding in the QI **Find SCP** generated responses.

The PACS shall not use the Specific Character Set Attribute (0008,0005), implying default setting.

6.4.2.1.2 Supported Study Root Query Levels and Search Schemes

The VistA Imaging QI Provider, as a **Find SCP**, supports Study Root Study/Series/Composite Object Instance Level queries. Relational searches are not supported yet but might be in the future. The following table describes the IAQ **Q/R User AE** C-FIND SCU Request attributes for the different level queries of the Study Root Hierarchical Information Model:

Attribute	Tag	Study Level Query Key Value	Series Level Query Key Value	COI (Image) Level Query Key Value
Query/Retrieve Level	(0008,0052)	STUDY	SERIES	IMAGE
Study Instance UID	(0020,000D)	1. zero length value for Study UID search or 2. Unique value for single-value match	Unique value for single-value match	Unique value for single-value match
Series Instance UID	(0020,000E)	Attribute omitted	1. zero length value for Series UIDs search or 2. Unique value for single-value match	Unique value for single-value match
SOP Instance UID	(0008,0018)	Attribute omitted	Attribute omitted	1. zero length value, 2. Single value, or 3. list of UIDs

Table 6-6: QI Consumer – Study Root Information Model Query Level Related Instance UID Settings

6.4.2.1.3 Study Level Matching Keys

C-FIND Matching Rule Notations are detailed in the introduction under 0.6.6.

Description		Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Query/Retrieve Level ("STUDY")		(0008,0052)	Required +	Required	S
Study Date		(0008,0020)	Required +	Required	S, r, U
Study Time		(0008,0030)	Required +	Required	r, U
Study ID		(0020,0010)	Required +	Required	S, *, U
Patient's Name	(IHE-1/2)	(0010,0010)	Required +	Required	S, *, U
Patient ID		(0010,0020)	Required +	Required	S, *, U
Accession Number		(0008,0050)	Required +	Required	S, *, U
Study Instance UID		(0020,000D)	UNIQUE - R+	UNIQUE - R	UNIQUE

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Modalities in Study	(0008,0061)	Required +	Required +	S, *, U
Referring Physician's Name (IHE-1/2)	(0008,0090)	Required +	Required +	S, *, U
Study Description	(0008,1030)	Optional	Optional	S, *, U
Procedure Code Sequence	(0008,1032)	Optional	Optional	S
>Code Value	(0008,0100)	Optional	Optional	S, U
>Coding Scheme Designator	(0008,0102)	Optional	Optional	U
>Coding Scheme Version	(0008,0103)	Optional	Optional	U
>Code Meaning	(0008,0104)	Optional	Optional	U
Name of Physician(s) Reading Study (IHE-1/2)	(0008,1060)	Optional	Optional	S, *, U
Other Patient IDs	(0010,1000)	Optional	Optional	S, *, U
Other Patient Names (IHE-1/2)	(0010,1001)	Optional	Optional	S, *, U
Patient's Age	(0010,1010)	Optional	Optional	U
Patient's Birth Date	(0010,0030)	Optional	Optional	S, *, U
Patient's Sex	(0010,0040)	Optional	Optional	S, *, U
Patient's Size (field not populated in production system)	(0010,1020)	Optional	Optional	S, *, U
Patient's Weight (field not populated in production system)	(0010,1030)	Optional	Optional	S, *, U
Ethnic Group	(0010,2160)	Optional	Optional	S, *, U
Interpretation Author (IHE-1/2)	(4008,010C)	Optional	Optional	S, *, U

Table 6-7: QI Consumer – SCP Study Root/Study Level Matching Keys

Other Study Level IHE RAD TF-2: 4.14 (RAD-14) extensions applied are:

Attributes Name	Tag	Required Keys	
		SCU	SCP
Patient's Birth Date	(0010,0030)	Required +	Required +
Patient's Sex	(0010,0040)	Required +	Required +
Number of Study Related Series	(0020,1206)	O	Required +

Number of Study Related Instances	(0020,1208)	O	Required +

<p align="center">**Table 6-8: QI Consumer – Study Root/Study Level IHE Required Keys**</p>

Note: not all IHE specified Matching and Required field requirements used by VistA Imaging on the Study level.

6.4.2.1.4 Series Level Matching Keys

C-FIND Matching Rule Notations are detailed in the introduction under 0.6.6.

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Query/Retrieve Level ("SERIES")	(0008,0052)	Required +	Required	S
Modality	(0008,0060)	Required +	Required	S, *, U
Series Number	(0020,0011)	Required +	Required	*, U
Series Instance UID	(0020,000E)	UNIQUE - R+	UNIQUE - R	UNIQUE

<p align="center">**Table 6-9: QI Consumer – SCP Study Root/Series Level Matching Keys**</p>

Other Series Level IHE RAD TF-2: 4.14 (RAD-14) extension applied are:

Attributes Name	Tag	Required Keys	
		SCU	SCP
Series Description	(0008,103E)	Required +	Required +
Number of Series Related Instances	(0020,1209)	Optional	Required +

<p align="center">**Table 6-10: QI Consumer – Study Root/Series Level IHE Required Keys**</p>

Note: not all IHE specified Matching and Required field requirements used by VistA Imaging on the Series level.

6.4.2.1.5 Object Instance Level Matching Keys

C-FIND Matching Rule Notations are detailed in the introduction under 0.6.6.

Description	Tag	SCU Matching Type	SCP Matching Type	SCP Matching Mode
Query/Retrieve Level ("IMAGE")	(0008,0052)	Required +	Required	S
Instance Number	(0020,0013)	Required +	Required	S, *, U
SOP Instance UID	(0008,0018)	UNIQUE - R+	UNIQUE - R	UNIQUE
SOP Class UID (IHE-4)	(0008,0016)	Optional	Required +	*

Table 6-11: QI Consumer – SCP Study Root/Object Instance Level Matching Keys

Attributes Name	Tag	Required Keys	
		SCU	**SCP**
Row	(0008,0010)	Optional	Required +
Column	(0008,0011)	Optional	Required +
Bits Allocated	(0008,0100)	Optional	Required +
Number of Frames	(0028,0008)	Optional	Required +

Table 6-12: QI Consumer – Study Root/Instance Level, Image Specific IHE Required Keys

Note that not all IHE specified Matching and Required field requirements used by VistA Imaging on the Object Instance level.

6.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert or above what is provided by the DICOM standard and/or recommended by IHE.

<Information may come as needed.>

7 PACS Query/Retrieve User AE – Retrieve Images (RI) Consumer Profile

7.1 Use Case

IHE RAD TF-2: 4.16 (**Rad-16**) with different Actors:
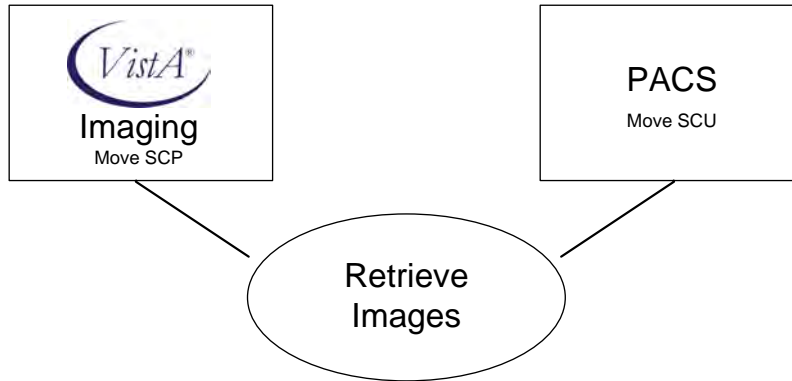
Actor: **VistA Imaging – Move SCP** (IHE Image Archive)

Role: Upon PACS Move request, manage delivery of Study, Series or single Composite Object Instances (images) to the PACS

Actor: **PACS – Move SCU** (IHE Image Display)

Role: Issue Move requests to retrieve Study, Series or single Composite Object Instances (images) from VistA Imaging.

7.2 Interactions

The actors in this use case shall perform the behaviors shown in the following sequence diagram.

7.3 Dynamic Definition

The PACS Move Request message, created by the Move SCU service, contains the Study Instance UID, a Series Instance UID, or the individual SOP Instance UIDs to identify the group of images (Composite Object Instances) to be delivered. This Move Request message re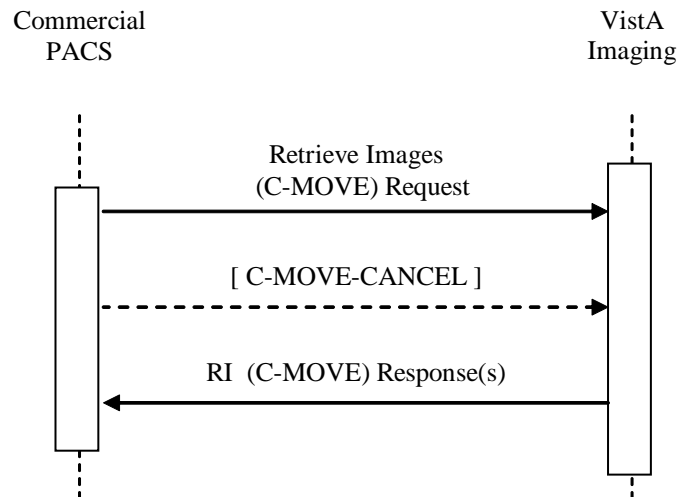quests VistA Imaging to send all designated DICOM Object Instances to an existing C-STORE SCP process running on the PACS. The AE title of the PACS C-STORE SCP is specified in the Move request.

The PACS's RI Consumer, the **Q/R User AE,** issues Study Root Study, Series and Composite Object Instance (Image) level C-MOVE requests. VistA Imaging's **Move SCP** is a Study Root Query/Retrieve Information Model - MOVE Service Class User (SCP) that transfers VistA Imaging Composite Object Instances of a requested Study, Series or list of Instances to the PACS. The designated study's Composite Object Instances are delivered to the PACS's **Storage Provider AE** via C-STORE requests issued by VistA Imaging's **Store SCU**. The VistA Imaging **Move SCP** is also a Study Root Query/Retrieve Information Model - FIND Service Class Provider (see QI Consumer Profile in Chapter 6) that can respond to C-FIND queries from the PACS to provide information about imaging Studies, Series and Composite Object Instances in VistA Imaging.

7.3.1 Business Requirements

7.3.1.1   The RI Implementation

The PACS RI Consumer, the **Q/R User AE** (Move) SCU will be instructed (by other PACS sub-systems) to issue the appropriate DICOM Move request to the VistA Imaging **Move SCP**. The **Q/R User AE** SCU will initiate a Study Root Study, Series, or Composite Object Instance Level Move request to VistA Imaging's RI Provider, the **Move SCP**.

7.3.1.2   The PACS Trigger Event

When a PACS user/application needs a Study, a Series, or a selected list of Object Instances that do not exist on the PACS, the PACS RI Consumer, the **Q/R User AE** (Move) SCU is instructed to retrieve the designated Object Instances.

7.3.1.3   Simultaneous Moves

The VistA Imaging **Move SCP** does support simultaneous moves. The maximum number of concurrent Simultaneous moves is resource bound only. The PACS must declare the number of moves its RI Provider, the **Q/R User AE** (Move) SCU can perform simultaneously.

7.3.1.4   Move Timing

The PACS RI Consumer, the **Q/R User AE** (Move) SCU must support a PACS configurable (up to several minutes) timeout between C-MOVE response messages that are NEARLINE items. For OFFLINE items human interaction is required, timeout cannot be specified.

7.3.1.5   Priority Processing

The VistA Imaging **Move SCP** does not support priority processing. Later versions might implement it upon need. For future interoperations, the PACS shall declare if its **Q/R User AE** SCU does support priority requests.

7.3.1.6   Response Message Limitations

VistA Imaging does not limit the maximum number of responses during C-MOVE operation.

7.3.1.7   Retrieve AE Title Specifics

VistA Imaging is able responding to Move Requests from and delivering DICOM Object Instances to an AE other than the PACS **Q/R User AE**.

7.3.1.8   Object Serving Behavior

The PACS will request DICOM Object Instance(s) from VistA Imaging by initiating a C-MOVE to VistA Imaging. Consequently, VistA Imaging is able to initiate a connection to and to transfer the requested DICOM Object Instance(s) to a PACS C-STORE AE (the **Storage Provider AE**).

7.3.1.9   No User Characteristics

The RI Consumer Profile implements a system-to-system interface. No User Characteristics are defined or assumed. Consequently, the IHE RAD TF-2: 4.16 Viewing related clauses do not apply in this PACS (as an archive Actor) specific profile. IHE RAD TF-2 sections waived are: 4.16.4.1.1 Trigger Events, and the entire section of 4.16.4.2 View Images.

7.3.2 Error Handling

7.3.2.1   Confirm the PACS RI Consumer's Move SCU Behavior

Verify that the **Q/R User AE** (Move) SCU's response handling meets the DICOM standard and IHE profile definitions: submit various RI Move Responses (messing up Pending response counters; failing Move SCU operation; forced error cases).

7.3.3 Functional Requirements

7.3.3.1   RI Move SCU

The PACS RI Consumer implementation shall act as a Study Root Query/Retrieve Information Model - MOVE Service Class Provider (SCP). The PACS **Q/R User AE** (Move) SCU shall issue only Study Root Study, Series, and Composite Object Instance Level Move requests to the VistA Imaging **Move SCP**.

7.3.3.2   Presentation Context

The table below lists the proposed presentation context for the **Q/R User AE** that is anticipated by **VistA Imaging** as a **Move SCP**:

Presentation Context Table					
Abstract Syntax		**Transfer Syntax**		**Role**	**Extended Negotiation**
Name	**UID**	**Name List**	**UID List**		
Study Root Query/Retrieve Information Model – MOVE	1.2.840.10008.5.1.4.1.2.2.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

Table 7-1: RI Consumer – Presentation Context

The **PACS**, in the **RI Consumer** role, shall support the Study Root Query/Retrieve Information Model – MOVE SOP class as an **SCU**, using the listed transfer syntax in the table above.

7.3.3.3   Request Message

The PACS **Q/R User AE** (Move) SCU shall be able to issue Study-Root Study, Series, and Composite Object Instance Level move requests to VistA Imaging to retrieve all designated Instances (Composite Objects).

7.3.3.4   Expected PACS Storage Provider AE Behavior

On Duplicte Object Instance reception, tt is not recommended to the PACS **Storage Provider AE** SCP to ignore the content of a newly received Object Instance and to declare the reception successful. Due to the fact that VistA Imaging is the system of records, the DICOM header of recently sent Object Instances might carry the latest patient and study information from the VistA database.

7.4 DICOM-Specific Definitions

7.4.1 SOP Level Definitions

The PACS RI **Q/R User AE** SCU shall support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Q/R Provider AE	Verification SOP Class	SCU	Verification (DICOM Echo)
	Study Root Query/Retrieve Information Model – MOVE	SCU	Image Transfer Request and Image Transfer Response on Study, Series, and Composite-Object-Instance Level

Table 7-2: RI Consumer – SOP Classes

7.4.1.1 Association Establishment Policies

7.4.1.1.1 General

The maximum PDU size offered by the current VistA Imaging **Move SCP** is 32768 bytes by default but can be altered during association negotiation. SOP Class Extended Negotiation is not supported.

The DICOM standard Application Context (1.2.840.10008.3.1.1.1) shall be specified.

7.4.1.1.2 Number of Simultaneous Associations

The maximum number of simultaneous associations the VistA Imaging **Move SCP** will maintain is resources bound only. The RI Consumer (**Q/R User AE** SCU) shall not expect response for more than defined number of simultaneous associations from the RI **Move SCP**.

7.4.1.2 Association Acceptance Policy

The RI Consumer (**Q/R User AE**) SCU does not need to accept associations.

7.4.1.3 RI Move SOP Specific Conformance

7.4.1.3.1 Study Root Query/Retrieve Information Model - MOVE SOP Class
The SOP Class conforms to the basic requirements set forth by the DICOM standard.

7.4.1.3.2 Expected RI Move SCU Behavior
The PACS RI Consumer (**Q/R User AE** SCU) directs the VistA Imaging **Move SCP** to establish an Association with an AE named by the PACS RI C-MOVE SCU (through a MOVE Destination AE Title). The Move SCP then notifies the VistA Imaging MIS **Store SCU** to perform C-STORE operations on specific images as requested by the PACS **Q/R User AE** (C-MOVE) SCU. Then the PACS MIS **Store Provider AE** C-STORE SCP will receive one or more of the designated SOP Instances with Image Storage Presentation Contexts listed in Table 0-5. The PACS MIS **Storage Provider AE** shall accept at least one of these Presentation Contexts.

An initial C-MOVE Response will always be sent to the SCU after confirming that the C-MOVE Request itself can be processed. After this acknowledgement, based on configuration, the VistA Imaging **Store SCU** may or may not return a Pending response to the invoking **Move SCP** to signal a periodic status of sending of each SOP Instance. The Pending response reports the number of remaining SOP Instances to be transferred, and the number of transferred SOP Instances having a successful, failed, or warning status respectively. The Q/R User AE shall be able to handle both scenarios.

When the number of Remaining C-STORE sub-operations reaches zero, the **Move SCP** will generate a final response with a status of Success, Warning, Failed or Refused. This response will indicate the number of C-STORE sub-operations returning the status of Success, Warning, and Failed. If the status of a C-STORE sub-operation was Failed a UID List will be returned as well. The PACS **Q/R User AE** (C-MOVE) SCU shall be able to handle such logic and interpret all response constructs.

7.4.1.3.3 C-MOVE-CANCEL Support

The PACS **Q/R User AE** (C-MOVE) SCU shall support the C-MOVE-CANCEL request to terminate an in-progress C-MOVE Request. The SCU, once issued a C-MOVE-CANCEL, shall recognize a response status of Canceled as an indication that the C-MOVE-CANCEL was successful. The SCP will first stop the C-STORE operations, then it will stop generating and returning C-MOVE Pending response entries, only a Canceled Status message is returned.

7.4.1.3.4 Expected RI Move SCU Behavior on NEARLINE Retrieval

If the Composite SOP Instances must be retrieved from long-term archive before it could be staged on on-line storage, there may a significant delay between the previous and the next C-MOVE Responses as exporting the SOP Instance from the Near-Line Storage media to on-line storage (staging) is usually time consuming. The PACS **Q/R User AE** (Move) SCU should anticipate such delays for NEARLINE Object Instances, by having a configuration setting for adjustable timeouts.

7.4.1.3.5 Expected RI Move SCU Behavior on OFFLINE Retrieval

For OFFLINE items it is not possible to predict the SOP Instance delivery delay, as human action is involved. The PACS **Q/R User AE** (Move) SCU shall not wait longer than it does for NEARLINE items as immediate retrieval will not occur. Instead the VistA Imaging **Store SCU** will return with a fairly quick Failure message, after it notifies VistA Imaging Service Personal for placing the Off-Line media in the Near-Line storage device, so the Move request will be successful at a later retry,

7.4.1.3.6 RI Move SCP behavior on corresponding RI Move SCP Response Codes

The following table details the meaning, expected behavior of the PACS C-MOVE SCP on all possible response codes:

Service Status	Further Meaning	Status Code	Related Fields	C-MOVE SCP Behavior
Success	Sub-operations complete – No Failures	0000	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	All the Composite SOP Instances have been successfully sent to the C-MOVE Destination (VistA Imaging Storage Provider AE).
Refused	Out of Resources – Unable to calculate number of matches	A701	(0000,0902)	Number of matches cannot be determined due to system failure. This status is returned if the VistA database is not functioning so the search for matches to the C-MOVE Request cannot be found. Error message is output, as an alert for VistA Imaging maintenance personnel, and logged to the Service Log.

Service Status	Further Meaning	Status Code	Related Fields	C-MOVE SCP Behavior
	Out of Resources – Unable to perform sub-operations	A702	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	C-STORE sub-operations cannot be performed due to failure to access Composite SOP Instances in archive, or failure of a C-STORE Request. For example, this Status will be returned if the required SOP Instances are determined to be off-line (i.e. the storage media has been removed from the Near-Line archive). Error message is output as an alert for VistA Imaging maintenance personnel, and logged to the Service Log.
	Move destination unknown	A801	(0000,0902)	The Destination Application Entity named in the C-MOVE Request is unknown to Move SCP. Error message is output to the Service Log.
Failed	Identifier does not match SOP Class	A900	(0000,0901) (0000,0902)	The C-MOVE identifier (of the Q/R User AE Move Request) contains invalid Elements or values, or is missing mandatory Elements or values for the specified SOP Class or retrieval level. Error message is output to the Service Log.
Cancel	Matching terminated due to Cancel Request	FE00	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	The C-MOVE SCU sent a Cancel Request. This has been acknowledged and the export of Composite SOP Instances to the C-MOVE Destination AE has been halted.
Pending	Sub-operations are continuing	FF00	(0000,1020) (0000,1021) (0000,1022) (0000,1023)	A Response with this Status Code is sent every time a Composite SOP Instance has been successfully sent to the C-MOVE Destination AE.

Table 7-3: RI Consumer – Move SCP Behavior on C-MOVE Response Status

7.4.1.3.7 *The Failed SOP Instance UID List*

The Failed SOP Instance UID List (0008,0058) specifies a list of UIDs of the C-STORE sub-operation SOP Instances for which the C-MOVE operation has failed. An Identifier in the C-MOVE response will contain the Failed SOP Instance UID List (0008,0058) for C-MOVE response status values of Canceled, Failure, Refused, or Warning. If no C-STORE sub-operation failed, the Failed SOP Instance UID List (0008,0058) is absent and therefore no Data Set shall be sent in the C-MOVE response. The PACS **Q/R User AE** shall be able to handle such responses.

7.4.2 IOD Level Definitions

7.4.2.1 Message Attributes

The PACS RI Consumer implementation, that is the **Q/R User AE** SCU, shall comply with the C-MOVE DIMSE Service specified in the DICOM Standard (PS 3.4-2008, Annex C). The **Q/R User AE** SCU shall conform to the DICOM standard as a Study Root Study, Series and Composite-Object-Instance Level Move Level C-MOVE SCP.

7.4.2.1.1 *No Specific Character Set*

Specific Character Set (0008,0005) shall not be present.

7.4.2.1.2 Supported Study Root Move Levels and Attributes

Study Root Study, Series, and Composite-Object-Instance Level move requests are generated. The following table describes the RI C-MOVE SCU Request attributes for the different level move requests following the Study Root Hierarchical Information Model:

Attribute	Tag	Study Level Move Value	Series Level Move Value	COI (Image) Level Move Value
Query/Retrieve Level	(0008,0052)	STUDY	SERIES	IMAGE
Study Instance UID	(0020,000D)	Unique value	Unique value	Unique value
Series Instance UID	(0020,000E)	Attribute omitted	1. Unique value , or 2. list of UIDs	Unique value
SOP Instance UID	(0008,0018)	Attribute omitted	Attribute omitted	1. Unique value, or 2. list of UIDs

Table 7-4: RI Consumer – Supported Study Root Move Attributes

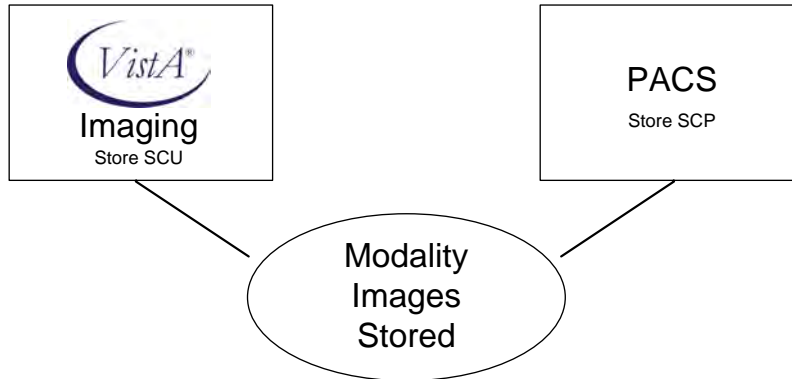## 7.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert or above what is provided by the DICOM standard and/or recommended by IHE.

<Information may come as needed.>

8 PACS Storage Provider AE – Modality Images Stored (MIS) Provider Profile

8.1 Use Case

IHE RAD TF-2: 4.8 (Rad-8) with different Actors:

**Actor**: **VistA Imaging – Store SCU** (IHE "Acquisition Modality")

Role: Send VistA Imaging image data (Composite Object Instances) to the PACS.

Actor: **PACS – Store SCP** (IHE Image Archive)

Role: Accept and store image data (Composite Object Instances) received from VistA Imaging.

8.2 Interactions

The actors in this use case shall perform the behaviors shown in the following sequence diagram.
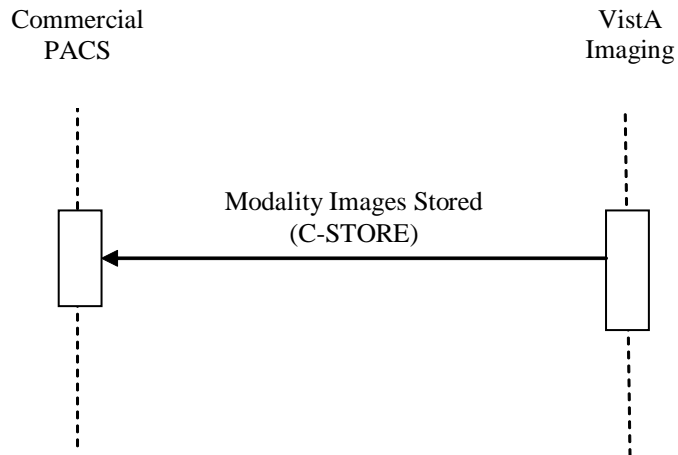
8.3 Dynamic Definition

VistA Imaging's **Store SCU** is a Storage Service Class User (SCU) that allows VistA Imaging to send DICOM Composite Object Instances to the requestor (PACS). When the VistA Imaging **Move SCP** receives C-MOVE requests from the PACS, it activates the **Storage SCU** to send the relevant Composite Object Instances from the VistA Imaging archive to the requestor's (PACS's) **Storage Provider AE** (SCP).

8.3.1 Business Requirements

8.3.1.1   MIS Implementation

When the PACS needs to access an earlier archived Study's Object Instances, the PACS can issue a Query request via the QI **Q/R User AE** (C-FIND) SCU to the VistA Imaging QI **Find SCP** to learn details of the Study, including all identifiers of the Study's Object Instances (see QI Provider Profile in Chapter 6). The PACS can then issue a Move request for all Object Instances of the Study using the RI Consumer Profile (see Chapter 7). The PACS, indirectly, through the VistA Imaging RI **Move SCP**, uses the current profile to manage the delivery of all DICOM Object Instances of the given Study from VistA Imaging's PACS MIS **Store SCU** to the PACS's own MIS **Storage Provider AE** SCP.

8.3.1.2   Trigger Events

A PACS user or a preset PACS delivery rule needs the Object Instances of a Study, a Series, or a select group that are not available on the PACS, but do exist in the VistA Imaging archive.

8.3.1.3   PACS Simultaneous Stores

The PACS must declare the number of moves its RI SCP can perform simultaneously.

8.3.1.4   PACS Store Performance

The PACS must specify the maximum and average delay that can occur between start and finish of MIS C-STORE data storage as a function of the stored data size (i.e., milliseconds per Mbyte). These delays, of course, shall not include network delivery times.

8.3.1.5   PACS Priority Processing

The PACS must declare if priority processing is supported or not with respect to other DIMSE operations being performed by the same SCP.

8.3.1.6   Move Object Serving Behavior

The PACS will Query/Retrieve DICOM Object Instance(s) of a Study, a Series, or a select group from VistA Imaging by initiating a C-MOVE request. Upon the reception of a PACS Move request, the VistA Imaging **Move SCP** will instruct the **Store SCU** to initiate a DICOM connection the PACS **Store Provider AE** SCP and will conduct the transfer of the requested DICOM Object Instance(s) between the two Store AEs.

8.3.1.7   No User Characteristics

The MIS Consumer Profile implements a system-to-system interface. No User Characteristics are defined or assumed.

8.3.2 Error Handling

8.3.2.1   Confirm PACS Store Response Message

Verify that the PACS C-STORE response message meets the DICOM standard and IHE profile definitions.

8.3.2.2   Send Badly Formed Store Request Message to the PACS

To determine what the PACS does in such use cases.

8.3.3 Functional Requirements

8.3.3.1   MIS Store SCP

The PACS MIS Provider is a **Store Provider AE** SCP implementation that shall act as a C-STORE DIMSE Service Class Provider (SCP) being able to receive all the SOP Classes listed with assigned Transfer Syntaxes in Table 0-5.

8.4 DICOM-Specific Definitions

8.4.1 SOP Level Definitions

The PACS MIS **Store Provider AE** SCP shall support the following real-world activities:

Application Entity	SOP Class	Role	Real-World Activity
Storage User AE	Verification SOP Class	SCP	Verification (DICOM Echo)
	Various Storage SOP Classes listed in Table 0-5	SCP	Storage of DICOM Object Instances

Table 8-1: MIS Provider – SOP Classes

See Table 0-5 for VistA Imaging **Store Provider AE** (SCP) Supported SOP classes in the introduction section.

8.4.1.1   MIS Store SOP Specific Conformance

8.4.1.1.1   Expected Response Codes

The MIS **Store Provider AE** SCP response codes and error handling shall be according to the DICOM standard.

8.4.1.1.2 *PACS Storage Process Error Handling*

The PACS shall detail its Storage process flow on particular error conditions (DIMSE timeout on C-STORE association; PDU, TCP/IP level timeout for the same situation; Association aborted by MIS **Store SCU**).

8.4.1.1.3 *MIS Store SCU Behavior on Response Codes*

PACS MIS **Store Provider AE** SCP response status messages will trigger the following MIS **Store SCU** behaviors:

Service Status	Further Meaning	Status Code (0000,0900)	Related Fields	Meaning – C-STORE SCU Behavior
Success		0000		Data Set stored – Send Next SOP Instance, as needed
Refused	Out of Resources	A7xx	(0000,0902)	Memory or disk space low –Stop sending data for a while
Error	Data Set does not match SOP Class	A9xx	(0000,0901) (0000,0902)	Data Set Not stored – try it again later for a limited time
	Cannot understand	Cxxx	(0000,0901) (0000,0902)	Data Set Not stored – try it again later for a limited time
Warning	Coercion of Data Elements	B000	(0000,0901) (0000,0902)	Data Set Not stored – try it again later for a limited time
	Data Set does not match SOP Class	B007	(0000,0901) (0000,0902)	Data Set Not stored – try it again later for a limited time
	Elements Discarded	B006	(0000,0901) (0000,0902)	Data Set Not stored – try it again later for a limited time

Table 8-2: MIS Provider – C-STORE SCU behavior on SCP Response Status Codes

8.4.2 IOD Level Definitions

8.4.2.1 **Privately Defined Functional Groups**

The VistA Imaging MIS Consumer as a **Store SCU** does not make use of any privately-defined Functional Groups (private elements) for multi-frame IODs that support Functional Groups.

8.4.2.2 **Referenced Pixel Data Use**

The VistA Imaging MIS **Store SCU** does not use C-STORE operations that use any referenced pixel data transfer syntax (like JPIP).

8.4.3 Element Level Definitions

This section itemizes IOD elements to explicitly define meaning in concert or above what is provided by the DICOM standard and/or recommended by IHE.

<Information may come as needed.>