Integrating the Healthcare Enterprise

IHE Radiology
Technical Framework Supplement

Mobile access to Health Documents for Imaging (MHD-I)

Trial Implementation

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Please verify you have the most recent version of this document. See here for Trial Implementation and Final Text versions and here for Public Comment versions.

Foreword

This is a supplement to the IHE Radiology Technical Framework V12.0. Each supplement undergoes a process of public comment and trial implementation before being incorporated into the volumes of the Technical Frameworks.

This supplement is published on May 30, 2014 for trial implementation and may be available for testing at subsequent IHE Connectathons. The supplement may be amended based on the results of testing. Following successful testing it will be incorporated into the Radiology Technical Framework. Comments are invited and can be submitted at http://www.ihe.net/Radiology_Public_Comments.

This supplement describes changes to the existing technical framework documents.

"Boxed" instructions like the sample below indicate to the Volume Editor how to integrate the relevant section(s) into the relevant Technical Framework volume.

Amend Section X.X by the following:

Where the amendment adds text, make the added text **bold underline**. Where the amendment removes text, make the removed text **~~bold strikethrough~~**. When entire new sections are added, introduce with editor's instructions to "add new text" or similar, which for readability are not bolded or underlined.

General information about IHE can be found at: www.ihe.net.

Information about the IHE Radiology domain can be found at: ihe.net/IHE_Domains.

Information about the organization of IHE Technical Frameworks and Supplements and the process used to create them can be found at: http://ihe.net/IHE_Process and http://ihe.net/Profiles.

The current version of the IHE Radiology Technical Framework can be found at: http://www.ihe.net/Technical_Frameworks.

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Introduction to this Supplement

The IT Infrastructure Technical Framework defines a profile to access XDS content using RESTful services, called Mobile access to Health Documents (MHD), but this does not provide a solution for images. MHD-I addresses that gap by leveraging the MHD transactions within an imaging context and provides access to DICOM instances via the WADO-URI and WADO-RS Retrieve methods.

Since the MHD-I Profile is aligned with the ITI MHD Profile, implementers are advised to follow developments with the MHD Profile.

Closed Issues

#	Issue / Answer
1.	**Why did we leverage the transactions in MHD, which states that the profile is not stable (from the supplement, "The IHE MHD Profile and the HL7 FHIR activities are working together to revise and enhance the transactions profiled here"), rather than creating the query and retrieve manifest transactions in this profile?** The MHD Profile provides sufficient underlying methodology to achieve the goals of this profile. With some restrictions on some of the transactions, it was deemed redundant to recreate them here, and with imposing specific restrictions on newly created transaction (such as limiting the query to just manifests), it left more to be desired. Should, in the future, the MHD Profile moves in a direction not suitable for MHD-I consumers, action will be taken then to have the MHD-I Profile updated.
2.	**This profile relies on ITI MHD Profile, but a noticeable gap is the lack of posting new documents. Why is this excluded?** For the use cases that MHD-I addresses, content creation is not feasible (i.e., on a mobile device, to acquire images in DICOM format, structure them in a study / series / instance hierarchy, and upload the content).
3.	**Should QIDO-RS be included in this profile?** No. QIDO-RS is not necessary to satisfy the MHD-I use cases.
4.	**Should WADO-RS or WADO-URI be mandatory?** URI is mandatory, and RS is optional. WADO-URI is widely supported, whereas WADO-RS is still fairly new at the time this profile was created. WADO-RS is also missing key functionality (rendering); however, that is being addressed in future DICOM work.
5.	**Should we use URI or URL as the terminology in the WADO-RS transaction, and do we need to indicate it must be fully qualified (absolute rather than relative)?** Sentences that reflected the inconsistency have been adjusted.
6.	**Should we incorporate DICOM CP 1352 regarding series and instance level metadata queries in metadata queries of WADO-RS?** Yes, this has been incorporated.
7.	**Should we incorporate DICOM CP 1351 regarding retrieving WADO-RS metadata in JSON, in particular Appendix X.2.x?** Yes, this has been incorporated.

#	Issue / Answer
8.	**When DICOM CP 1350 to include a URL in the KOS manifest is completed, should we update the JSON Imaging Manifest to recommend it be included by XDS-I systems?** No, a separate CP should be created to add WADO-RS to XDS-I.b and any other relevant profiles.
9.	**In the example, we copied the formatCode from the XDS-I.b manifest registry metadata format code as the class code for the MHD JSON representation of the manifest header. We selected our own display name since that is not specified in XDS-I.b. Is this correct?** Yes, this is correct.
10.	**Should the home community ID be required for the MHD-I Profile retrieve transactions even for cross-community (rather than cross-enterprise access) to assure all implementations in the future support cross-community access?** This will be considered when MHD-I is addressed with XCA-x.
11.	**Is Instance-Stored the correct ATNA event for a WADO-RS retrieval? (That is what is used in WADO-URI, where this originated)** Yes, this is consistent with WADO-URI.

General Introduction

Update the following Appendices to the General Introduction as indicated below. Note that these are not appendices to Volume 1.

Appendix A - Actor Summary Definitions

Add the following actors to the IHE Technical Frameworks General Introduction list of actors:

None

Appendix B - Transaction Summary Definitions

Add the following transactions to the IHE Technical Frameworks General Introduction list of Transactions:

Transaction	Definition
RAD-107	WADO-RS Retrieve

Glossary

Add the following glossary terms to the IHE Technical Frameworks General Introduction Glossary:

Glossary Term	Definition
JSON	JavaScript Object Notation
WADO-RS	Web Access to DICOM Objects by RESTful Services

Volume 1 – Profiles

Add Section 36 to Volume 1

36 Mobile access to Health Documents for Imaging (MHD-I) Profile

The IT Infrastructure Technical Framework defines a profile to access XDS content using RESTful services, called Mobile access to Health Documents (MHD), but this does not provide a solution for images. MHD-I addresses that gap by leveraging the MHD transactions within an imaging context and provides access to DICOM instances via the WADO-URI and WADO-RS Retrieve methods.

Since the MHD-I Profile is aligned with the ITI MHD Profile, implementers are advised to follow developments with the MHD Profile.

This profile re-uses transactions from the IHE IT Infrastructure Mobile access to Health Documents (MHD) profile for registry queries / repository retrievals. MHD-I is both a content profile and a transport profile. It defines a new content type for encoding the study manifest. MHD-I defines WADO-RS as an option to transport DICOM instances, series, and studies via RESTful services, but requires the WADO-URI transaction WADO Retrieve [RAD-55].

Full examples of the transactions of this profile can be found in RAD TF-3: Appendix X.

36.1 MHD-I Actors, Transactions, and Content Modules

This section defines the actors, transactions, and/or content modules in this profile.

Figure 36.1-1 shows the actors directly involved in the MHD-I Profile and the relevant transactions between them. If needed for context, other actors that may be indirectly involved due to their participation in other related profiles are shown in dotted lines. Actors which have a mandatory grouping are shown in conjoined boxes.

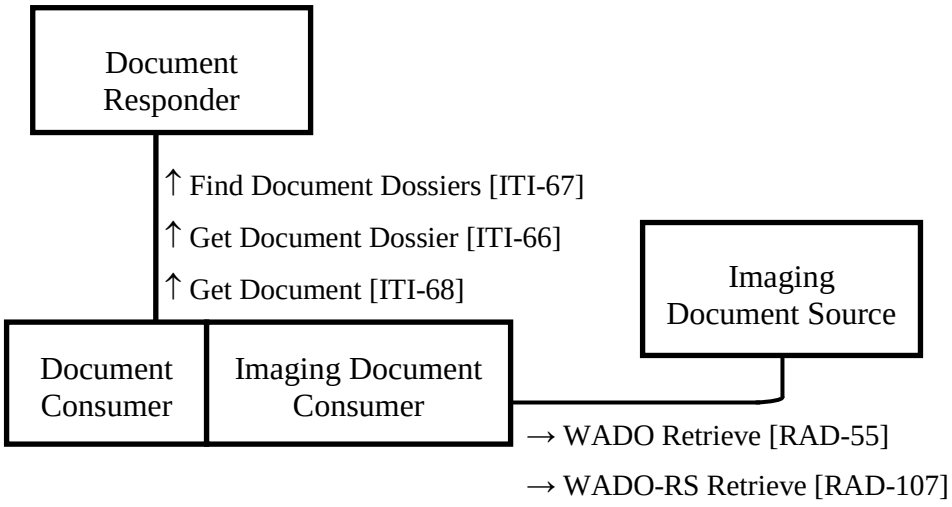


Figure 36.1-1: MHD-I Actor Diagram

Table 36.1-1 lists the transactions for each actor directly involved in the MHD-I Profile. To claim compliance with this profile, an actor shall support all required transactions (labeled "R") and may support the optional transactions (labeled "O").

Table 36.1-1: MHD-I Profile - Actors and Transactions

Actors	Transactions	Optionality	Reference
Document Responder	Find Document Dossiers [ITI-67]	R	ITI TF-2b: 3.67
	Get Document Dossier [ITI-66]	R	ITI TF-2b: 3.66
	Get Document [ITI-68]	R	ITI TF-2b: 3.68
Document Consumer	Find Document Dossiers [ITI-67]	R	ITI TF-2b: 3.67
	Get Document Dossier [ITI-66]	R	ITI TF-2b: 3.66
	Get Document [ITI-68]	R	ITI TF-2b: 3.68
Imaging Document Consumer	WADO Retrieve [RAD-55]	R	RAD TF-3: 4.55
	WADO-RS Retrieve [RAD-107]	O	RAD TF-3: 4.107
Imaging Document Source	WADO Retrieve [RAD-55]	R	RAD TF-3: 4.55
	WADO-RS Retrieve [RAD-107]	O	RAD TF-3: 4.107

Table 36.1-2 lists the content defined in the MHD-I Profile. To claim support with this profile, an actor shall support all required content (labeled "R").

Table 36.1-2: MHD-I Profile - Actors and Content

Actors	Content	Optionality	Reference
Document Responder	JSON Imaging Manifest	R	RAD TF-3: 6.2
Document Consumer	JSON Imaging Manifest	R	RAD TF-3: 6.2

36.1.1 Actor Descriptions and Actor Profile Requirements

Most requirements are documented in Transactions (Volumes 2 and 3) and Content Modules (Volume 3). This section documents any additional requirements on this profile's actors.

36.1.1.1 Document Consumer

The ITI Mobile access to Health Documents (MHD) Profile specifies the Document Consumer Actor. The MHD-I Profile uses the transactions defined in MHD to access documents, but MHD-I constrains the Document Consumer to find and retrieve JSON Imaging Manifests for a patient.

The Document Consumer shall use the Find Document Dossiers [ITI-67] transaction to find manifests constrained to the formatCode for JSON Imaging Manifest, which is "urn:ihe:rad:jsonimagingmanifest". The manifests identify images in one or more studies and their location.

36.1.1.2 Document Responder

The ITI Mobile access to Health Documents (MHD) Profile specifies the Document Responder Actor. In the MHD-I Profile, the Document Responder responds to requests for a patient's documents filtered by the formatCode for a JSON Imaging Manifest, which is "urn:ihe:rad:jsonimagingmanifest".

The Document Responder shall format the returned manifest as defined in the JSON Imaging Manifest in RAD TF-3: 6.2.1 when responding to Get Document [ITI-68].

36.1.1.3 Imaging Document Consumer

The Imaging Document Consumer retrieves instances identified in a JSON Imaging Manifest from an Imaging Document Source using WADO Retrieve [RAD-55] or, optionally WADO-RS Retrieve [RAD-107].

36.1.1.4 Imaging Document Source

The Imaging Document Source provides DICOM instances requested by the Imaging Document Consumer using WADO Retrieve [RAD-55] or, optionally WADO-RS Retrieve [RAD-107].

36.2 MHD-I Actor Options

Options that may be selected for each actor in this profile, if any, are listed in the Table 36.2-1. Dependencies between options when applicable are specified in notes.

Table 36.2-1: Mobile access to Health Documents for Imaging - Actors and Options

Actor	Option Name	Reference
Document Responder	No options defined	--
Document Consumer	No options defined	--
Imaging Document Consumer	WADO-RS Option	RAD TF-3: 4.107
Imaging Document Source	WADO-RS Option	RAD TF-3: 4.107

36.2.1 WADO-RS Option

The Imaging Document Consumer and the Imaging Document Source that claim the WADO-RS Option shall support the WADO-RS Retrieve [RAD-107] transaction.

36.3 MHD-I Required Actor Groupings

An actor from this profile (Column 1) shall implement all of the required transactions and/or content modules in this profile in addition to all of the transactions required for the grouped actor (Column 2).

Table 36.3-1: Mobile access to Health Documents for Imaging - Required Actor Groupings

MHD-I Actor	Actor to be grouped with	Reference	Content Bindings Reference
Document Responder	None	--	RAD TF-3: 6.2
Document Consumer	MHD-I Imaging Document Consumer	RAD TF-1: 36.1	RAD TF-3: 6.2
Imaging Document Consumer	MHD-I Document Consumer	RAD TF-1: 36.1	--
Imaging Document Source	None	--	--

Section 36.5 describes some optional groupings that may be of interest for security considerations and Section 36.6 describes some optional groupings in other related profiles.

36.4 MHD-I Overview

36.4.1 Concepts

MHD-I enables retrieval of imaging studies (performed procedures) shared within an enterprise and across communities. It can leverage the infrastructure provided by the Cross Enterprise Document Sharing for Imaging (XDS-I.b) Profile. It also incorporates the RESTful transactions from IT Infrastructure's Mobile access to Health Documents (MHD) Profile.

An MHD-I consumer requires only a patient identifier to locate and retrieve studies, series or instances.

XDS-I.b retrieves studies and documents within an enterprise, by recording metadata in a registry, by storing a manifest (a study structure document, represented by a DICOM KOS object) in a repository and including links in this manifest to retrieve the actual instances.

MHD provides mechanisms to interact with XDS.b registries and repositories using RESTful technologies. MHD defines methods to query and retrieve document dossiers for a given patient. MHD uses the term "dossier" to refer to the metadata (such as the study description and originating facility) stored about a single document in XDS. MHD also defines a method to retrieve the document; in the case of MHD-I, the document is a JSON Imaging Manifest.

MHD-I does not directly depend on XDS-I.b and so can be implemented with other architectures.

Retrieving radiology reports and other documents may be done using the ITI MHD Profile (without MHD-I) and is not described in the MHD-I Profile.

36.4.2 Use Cases

36.4.2.1 Use Case #1: Study Selection and Retrieval

36.4.2.1.1 Study Selection and Retrieval Use Case Description

A radiologist, using a mobile or desktop device, has been asked to have a quick review of some images of a patient. In his EMR client, he looks up the patient details. He would like to discover what studies are available for his patient in the XDS-I repository. He queries the responder for his patient using the patient's identifier provided by the EMR client, and discovers several studies. He then selects one study, and his device retrieves the manifest, which provides the references to each DICOM composite object. With this information, his device is able to retrieve the instances via WADO, and render them.

36.4.2.1.2 Study Selection and Retrieval Process Flow

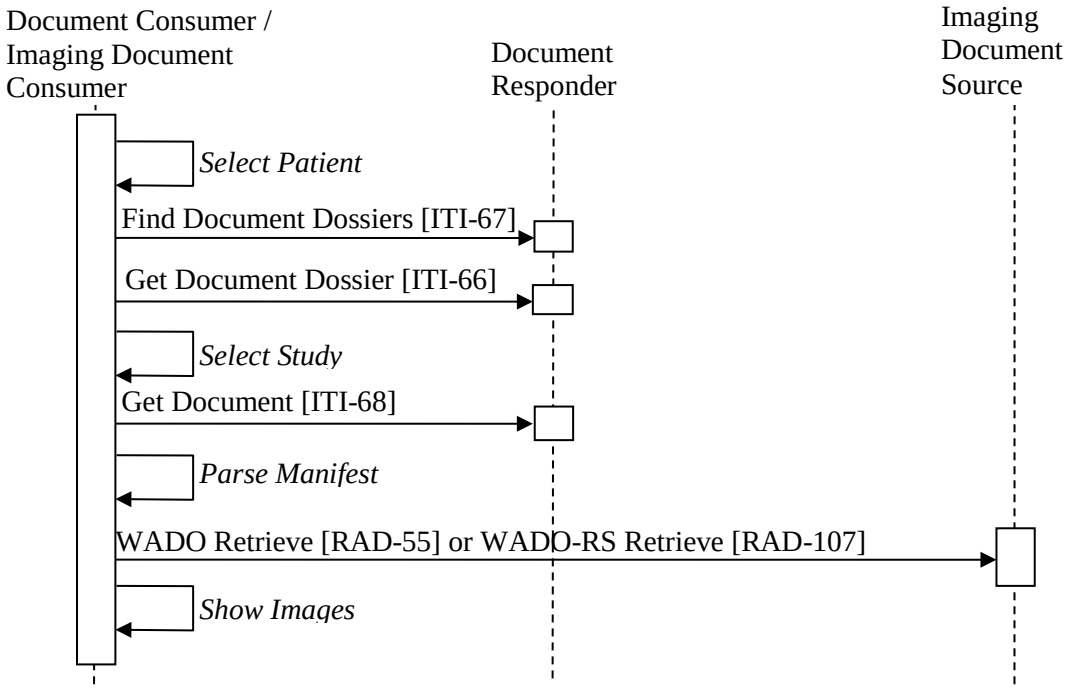


Figure 36.4.2.1.2-1: Study Selection and Retrieval Process Diagram in MHD-I Profile

Note: Although not shown in the diagram above, if WADO Retrieve [RAD-55] is used, a separate request for each SOP Instance UID in the manifest would have to be made. If WADO-RS Retrieve [RAD-107] is used, a request can be made at the Study, Series, or SOP Instance level.

An example of the transactions supporting this use case can be found in RAD TF-3: Appendix X.1.

36.4.2.2 Use Case #2: Instance Metadata Retrieval

36.4.2.2.1 Instance Metadata Retrieval

A radiologist has selected a CT study and now has opted to perform a 3D reconstruction on his client (mobile or desktop device). The client needs metadata from each DICOM instance header, such as slice thickness and patient position and orientation, in order to select appropriate instances of the study for rendering. As the client has retrieved the manifest in the previous use case (Section 36.4.2.1), it submits a metadata retrieval request, which downloads all of the DICOM headers for each instance in the study in a single response. The client parses this information and then proceeds to download the relevant instances.

36.4.2.2.2 Instance Metadata Process Flow

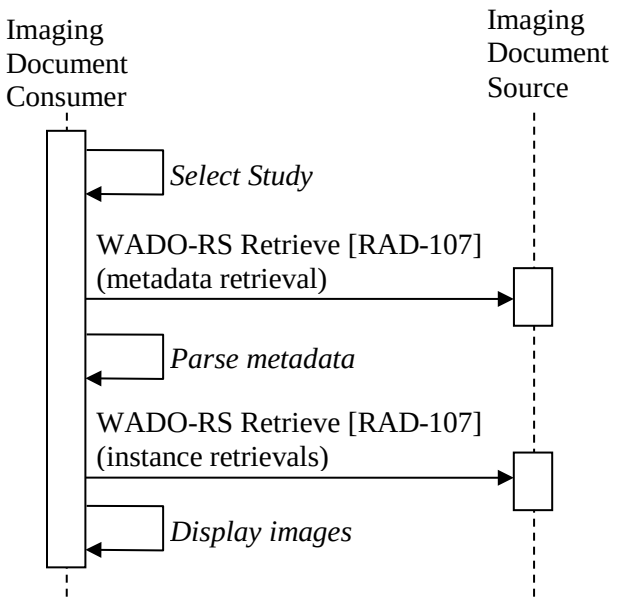


Figure 36.4.2.2.2-1: Instance Metadata Process Flow in MHD-I Profile

Note: Although not shown in the diagram above, since the client makes determinations to retrieve specific instances, a WADO-RS call would have to be made for each specific SOP Instance.

This use case is only supported with the WADO-RS Retrieve Option; WADO Retrieve [RAD-55] has no metadata retrieval capability. An example of the transactions can be found in RAD TF-3: Appendix X.2.

36.4.2.3 Use Case #3: Key Image

36.4.2.3.1 Key Image Use Case Description

An ER physician using an EMR client wishes to see key images for a selected patient study. The client parses the manifest looking for Key Image Note documents. When the Key Image Notes

are retrieved, they in turn are parsed and the referenced images are retrieved for display to the ER Physician with appropriate annotation from the Key Image Note document.

Note: The IHE Radiology IOCM Profile defines specific Key Image Note titles for rejection of instances and describes expected behavior.

36.4.2.3.2 Key Image Selection Process Flow

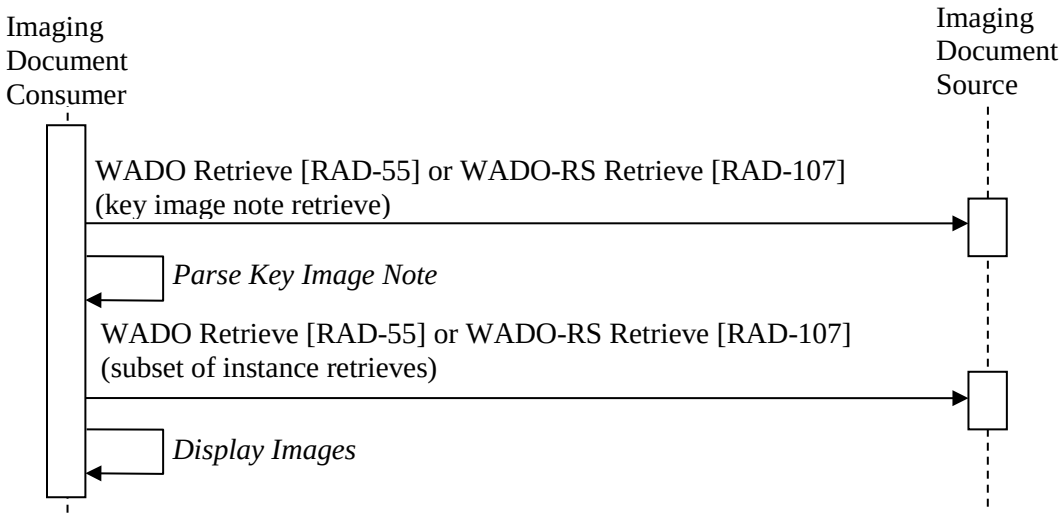


Figure 36.4.2.3.2-1: Key Image Selection Process Flow in MHD-I Profile

Note: Although not shown in the diagram above, if WADO Retrieve [RAD-55] is used, a separate request for each SOP Instance UID in the manifest would have to be made. If WADO-RS Retrieve [RAD-107] is used, a request can be made at the Study, Series, or SOP Instance level.

When WADO Retrieve is used to retrieve the Key Image Note, it is encoded as binary DICOM.

When WADO-RS Retrieve is used to retrieve the Key Image Note, it may be encoded as binary DICOM, as a Native DICOM Model in XML, or as a DICOM JSON Model.

An example of the transactions can be found in RAD TF-3: Appendix X.3.

36.5 MHD-I Security Considerations

The Mobile access to Health Documents for Imaging (MHD-I) Profile has the same security considerations as the IT Infrastructure Mobile access to Health Documents (MHD) Profile, in IHE ITI TF-1: 33.5. These include recommendations for secure transportation, authentication and authorization. Implementers are encouraged to review that section for applicability to their product ecosystem and environment.

The MHD-I Profile also has the same auditing considerations as the MHD Profile, in ITI TF-1:33.6.1. Implementers should consider that, when MHD-I is combined with XDS-I.b, the same event could be audited by both the Document Responder and the Document Registry. Implementers may also want to consider whether to include client-side auditing; for example mobile devices may be less likely to have access to an auditing infrastructure.

Implementers may also consider implementing Cross-Origin Resource Sharing (CORS) support to allow for browser-based clients to retrieve information from distributed sources (for example, manifests are downloadable from server A, and instances are downloadable from server B).

36.6 MHD-I Cross Profile Considerations

36.6.1 XDS-I.b – Cross-Enterprise Document Sharing for Imaging

A Document Responder might be grouped with the Document Consumer in XDS.b. The XDS.b Document Consumer could use Registry Stored Query [ITI-18] and Retrieve Document Set [ITI-43] to obtain data about stored images which the Document Responder would use to respond to incoming MHD-I queries in Find Document Dossiers [ITI-67].

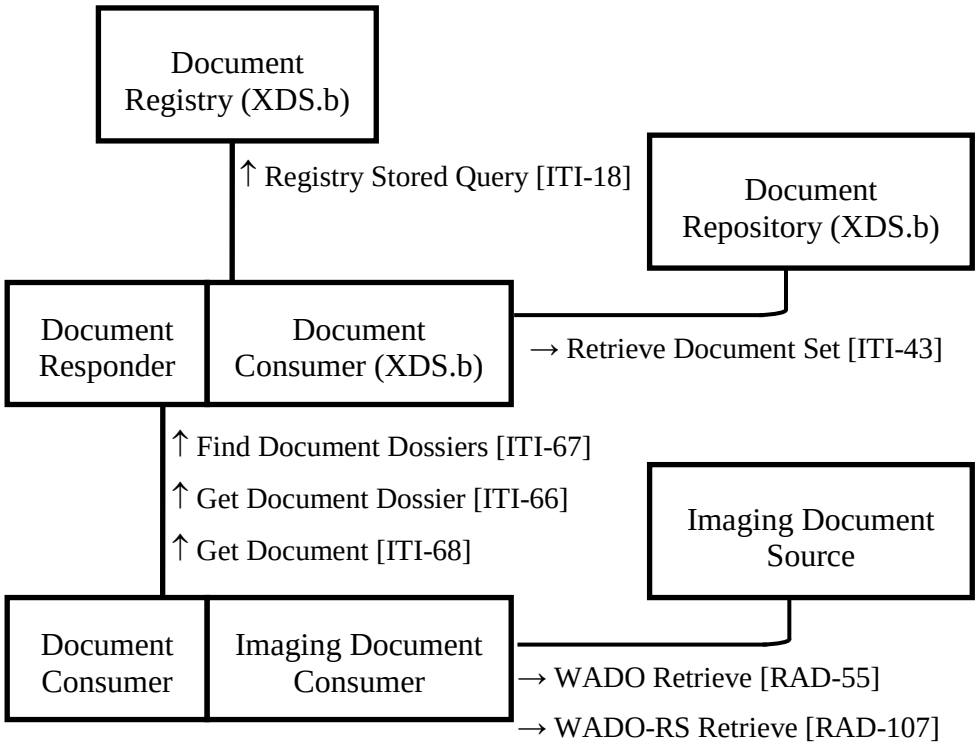


Figure 36.6.1-1: Cross Profile Consideration with XDS-I.b

When an MHD-I Document Consumer queries for a dossier, the Document Responder will query the registry for metadata about the manifest (stored in the document repository as a DICOM Manifest and encoded as a KOS Object) that matches the patient ID.

When the MHD-I Document Consumer requests the manifest, the Document Responder will retrieve the DICOM Manifest from the document repository and transform the DICOM Manifest into a JSON Imaging Manifest.

The URLs embedded in the JSON Imaging Manifest may be WADO-URI URLs that point directly to the XDS-I.b Imaging Document Source.

If the WADO-RS Option is supported, since XDS-I.b does not define a WADO-RS transaction, the Document Responder needs to retrieve the DICOM instances from the XDS-I.b Imaging Document Source and use those to respond to WADO-RS transactions. Alternatively, if the MHD-I Imaging Document Responder is grouped with the Imaging Document Source, a more direct implementation is possible.

36.6.2 XCA-I – Cross-Community Access for Imaging (XCA-I)

A Document Responder might be grouped with the Initiating Imaging Gateway Actor in XCA-I to provide an MHD-I front-end to XCA-I.

For this to occur, the Initiating Imaging Gateway needs to manipulate the responses in Find Document Dossiers [ITI-67] and Get Document [ITI-68] to re-write the URLs specified, to point to the Initiating Imaging Gateway with parameters for Home Community ID and destination URL (that will be called by the Responding Imaging Gateway). The manner of URL re-writing is not defined in the MHD-I Profile.

Volume 3 – Transactions

Add Section 4.107

4.107 WADO-RS Retrieve [RAD-107]

4.107.1 Scope

The WADO-RS Retrieve transaction accesses DICOM SOP Instances via an HTTP interface.

For information on how to map DICOM AE Title or Retrieve Location UIDs to WADO-RS, see Appendix G.X.

4.107.2 Actor Roles

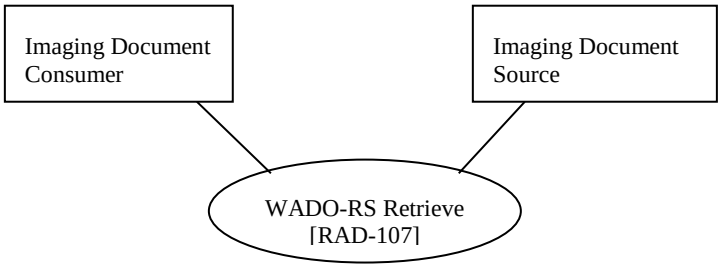


Figure 4.107.2-1: Use Case Diagram

Table 4.107.2-1: Actor Roles

Actor:	Imaging Document Consumer
Role:	Requests DICOM instances.
Actor:	Imaging Document Source
Role:	Returns DICOM instances.

4.107.3 Referenced Standards

IETF RFC1738, Uniform Resource Locators (URL), http://www.ietf.org/rfc/rfc1738.txt

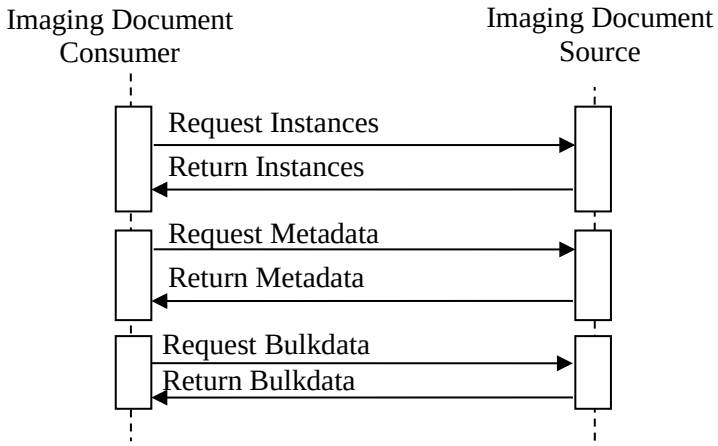
IETF RFC2616 HyperText Transfer Protocol HTTP/1.1, http://www.ietf.org/rfc/rfc2616.txt

IETF RFC4627 The application/json Media Type for JavaScript Object Notation (JSON), http://www.ietf.org/rfc/rfc4627.txt

Extensible Markup Language (XML) 1.0 (Second Edition). W3C Recommendation 6 October 2000. http://www.w3.org/TR/REC-xml

390 DICOM PS3.18: Web Services

4.107.4 Interaction Diagram



4.107.4.1 Request Instances

4.107.4.1.1 Trigger Events

395 The Imaging Document Consumer wishes to retrieve DICOM instances.

4.107.4.1.2 Message Semantics

The message is a DICOM WADO-RS request. The Imaging Document Source is the WADO-RS Server, and the Imaging Document Consumer is the WADO-RS Client.

The request shall correspond to one of the WADO-RS Action Types listed in Table 4.107.4.1.2-
400 1. The only binding required for both the Imaging Document Source and the Imaging Document Consumer is to HTTP-GET.

The Imaging Document Consumer must know the location to perform this transaction.

Table 4.107.4.1.2-1: WADO-RS Action Types

Action Type	URL	Expected Response
RetrieveStudy	http://<location>/studies/<studyUID>	All instances within the specified study
RetrieveSeries	http://<location>/studies/<studyUID>/series/<seriesUID>	All instances within the specified series
RetrieveInstance	http://<location>/studies/<studyUID>/series/<seriesUID>/instances/<instanceUID>	Specified instance
RetrieveFrames	http://<location>/studies/<studyUID>/series/<seriesUID>/instances/<instanceUID>/frames/<frameList>	Specified frames within the specified instance

The parameters of the request are defined in Table 4.107.4.1.2-2. All path parameter names are case-sensitive.

Table 4.107.4.1.2-2: WADO-RS Request Path Parameters

Path Parameter	Description	Notes
location	The host name, an optional port address, and may be followed by an optional path	See the discussion about location in ITI TF-2a: 3.11.4.1.2 Message Semantics.
studyUID	Study Instance UID of the study to be returned.	Shall be formatted as a DICOM UID.
seriesUID	Series Instance UID of the series to be returned.	Shall be formatted as a DICOM UID.
instanceUID	SOP Instance UID of the instance to be returned.	Shall be formatted as a DICOM UID.
frameList	Frame numbers of the frames to be returned from the SOP instance.	Shall be a comma-separated list of frame numbers, in any order, of non-duplicated integers.

The request shall include the header parameters defined in Table 4.107.4.1.2-3 to indicate the type of response to return. All header names and values are case-sensitive.

Table 4.107.4.1.2-3: WADO-RS Request Header Parameters

Header Name	REQ	Description
Accept	R	The representation scheme being posted to the RESTful service. Accepted values depend on the request made; refer to DICOM PS3.18 for accepted types.

The Imaging Document Consumer may perform the request to the web service utilizing HTTPS protocol.

4.107.4.1.2.1 Example of a WADO-RS Request-URI

The following is an example of HTTP Request-URI for retrieving a composite DICOM object using WADO-RS:

```
https://www.hospital.com/studies/1.2.250.1.59.40211.12345678.678910/ser
ies/1.2.250.1.59.40211.789001276.14556172.67789/instances/1.2.250.1.59.
40211.2678810.87991027.899772.2
Accept: multipart/related; type=application/dicom
```

This example uses an accept header of application/dicom to request the DICOM SOP Instance returned in the native DICOM PS3.10 file format.

4.107.4.1.3 Expected Actions

The Imaging Document Source shall parse the request and return a response as described in 4.107.4.2.

The Imaging Document Source shall respond using HTTPS if requested.

4.107.4.2 Return Instances

4.107.4.2.1 Trigger Events

The Request Instances message initiates this action.

4.107.4.2.2 Message Semantics

The message shall be a DICOM WADO-RS response. It is implemented as an HTTP response.

It is a multipart/related media type with each part containing a DICOM instance, as requested.

The Imaging Document Source shall provide a response message header containing the appropriate status code indicating success, warning, or failure. See DICOM PS3.18 Table 6.5-2. HTTP redirect responses to a request, specified by the HTTP 1.1 response code, are also valid.

4.107.4.2.3 Expected Actions

The Imaging Document Consumer receives the data requested, or an error response, or a request to look elsewhere for the data. The Imaging Document Consumer shall follow redirects (responses with values of 301, 302, 303 or 307), but if a loop is detected, it may report an error.

The Imaging Document Consumer processes the returned responses in a manner that is specific to its application. IHE does not mandate application-specific behavior.

4.107.4.3 Request Metadata

4.107.4.3.1 Trigger Events

The Imaging Document Consumer wishes to retrieve metadata regarding DICOM instances.

4.107.4.3.2 Message Semantics

The message shall be a DICOM WADO-RS request, corresponding to one of the WADO-RS Action Types in Table 4.107.4.3.2-1. It is implemented as an HTTP request. The only binding required for both the Imaging Document Source and the Imaging Document Consumer is to HTTP-GET.

The Imaging Document Source is the WADO-RS Server, and the Imaging Document Consumer is the WADO-RS Client.

The Imaging Document Consumer must already know the URI to perform this transaction.

Table 4.107.4.3.2-1: WADO-RS Action Types

Action Type	URL	Expected Response
RetrieveMetadata	http://<location>/studies/<studyUID>/metadata	All metadata within the specified study

Action Type	URL	Expected Response
RetrieveMetadata	http://<location>/studies/<studyUID>/series/<seriesUID>/metadata	All metadata within the specified series
RetrieveMetadata	http://<location>/studies/<studyUID>/series/<seriesUID>/instances/<instanceUID>/metadata	All metadata for a specified instance

Note: The series and instance level RetrieveMetadata are currently in ballot as DICOM CP1352 and expected to be approved in June 2014.

The parameters of the request are defined in Table 4.107.4.1.2-2. All path parameter names are case-sensitive.

The request shall include the header parameters defined in Table 4.107.4.1.2-3 to indicate the type of response to return. All header names and values are case-sensitive.

The Imaging Document Consumer may perform the request to the web service utilizing HTTPS protocol.

4.107.4.3.2.1 Example of WADO-RS Request Metadata

The following is an example for retrieving a composite DICOM object using WADO-RS:

```
https://www.hospital.com/studies/1.2.250.1.59.40211.12345678.678910/met
adata
Accept: multipart/related; type=application/dicom+xml
```

This example uses an accept header for application/dicom+xml to request the DICOM SOP Instance metadata returned in the Native DICOM Model in XML.

4.107.4.3.3 Expected Actions

The Imaging Document Source shall parse the request and return responses described in 4.107.4.4.

The Imaging Document Source shall respond using HTTPS if requested.

4.107.4.4 Return Metadata

4.107.4.4.1 Trigger Events

The Request Metadata message initiates this action.

4.107.4.4.2 Message Semantics

The message shall be a DICOM WADO-RS response. It is implemented as an HTTP response.

It is a multipart/related media type with each part containing DICOM instance metadata, as requested. It shall use the negotiated character set.

The Imaging Document Source shall provide a response message header containing the appropriate status code indicating success, warning, or failure. See DICOM PS3.18 Table 6.5-2. HTTP redirect responses to a request, specified by the HTTP 1.1 response code, are also valid.

4.107.4.4.3 Expected Actions

The Imaging Document Consumer receives the data requested, or an error response, or a request to look elsewhere for the data. The Imaging Document Consumer shall follow redirects (responses with values of 301, 302, 303 or 307), but if a loop is detected, it may report an error.

The Imaging Document Consumer processes the returned responses in a manner that is specific to its application. IHE does not mandate application-specific behavior.

4.107.4.5 Request Bulk Data

4.107.4.5.1 Trigger Events

The Imaging Document Consumer wishes to retrieve bulk data referenced in a Native DICOM Model in XML or DICOM JSON Model document.

4.107.4.5.2 Message Semantics

The message shall be a DICOM WADO-RS request, corresponding to one of the WADO-RS Action Types listed in Table 4.107.4.5.2-1. The message is implemented as an HTTP request. The only binding required for both the Imaging Document Source and the Imaging Document Consumer is to HTTP-GET.

The Imaging Document Source is the WADO-RS Server, and the Imaging Document Consumer is the WADO-RS Client.

The Imaging Document Consumer must already know the URI to perform this transaction.

Table 4.107.4.5.2-1: WADO-RS Action Types

Action Type	URL	Expected Response
RetrieveBulkdata	http://< bulkdataURL>	The data contained by the bulk data reference

The request shall include the header parameters defined in Table 4.107.4.5.2-2 to indicate the type of response to return. All header names and values are case-sensitive.

Table 4.107.4.5.2-2: WADO-RS Request Header Parameters

Header Name	REQ	Description
Accept	R	The representation scheme being posted to the RESTful service. Accepted values include: multipart/related; type=application/octet-stream multipart/related; type={MediaType}
Range	O	See RFC 2616 Section 14.35. If omitted in the request the server shall return the entire bulk data object

The Imaging Document Consumer may perform the request to the web service utilizing HTTPS protocol.

4.107.4.5.2.1 Example of Request Bulk Data

The following is an example of HTTP Request-URI for retrieving a composite DICOM object using WADO-RS:

```
https://www.hospital.com/stuff/hfslkhgkjhgkdjhdk
Accept: multipart/related; type=application/octet-stream
```

This example uses an accept header for application/octet-stream to request uncompressed bulk data.

4.107.4.5.3 Expected Actions

The Imaging Document Source shall parse the request and return responses as described in 4.107.4.6.

The Imaging Document Source may return HTTP redirect responses to a request.

The Imaging Document Source shall respond using HTTPS if requested.

4.107.4.6 Return Bulk Data

4.107.4.6.1 Trigger Events

The Request Bulk Data message initiates this action.

4.107.4.6.2 Message Semantics

The message shall be a DICOM WADO-RS response. It is implemented as an HTTP response.

It is a multipart/related media type with a single part containing DICOM instance bulk data, as requested.

The Imaging Document Source shall provide a response message header containing the appropriate status code indicating success, warning, or failure. See DICOM PS3.18 Table 6.5-2. HTTP redirect responses to a request, specified by the HTTP 1.1 response code, are also valid.

4.107.4.6.3 Expected Actions

The Imaging Document Consumer can expect to receive the data requested, or an error response, or a request to look elsewhere for the data. The Imaging Document Consumer shall follow redirects (responses with values of 301, 302, 303 or 307), but if a loop is detected, it may report an error.

The Imaging Document Consumer processes the returned responses in a manner that is specific to its application. IHE does not mandate application-specific behavior.

4.107.5 Security Considerations

4.107.5.1 Security Audit Considerations

The Radiology Audit Trail Option in the IHE ITI Audit Trail and Node Authentication Profile (ITI TF-1:9) defines audit requirements for IHE Radiology transactions. See RAD TF-3:5.1.

Add to Section 5 Namespaces and Vocabularies

codeSystem	codeSystemName	Description
urn:ihe:rad:jsonimagingmanifest	urn:ihe:rad:xdsi-b:2009	JSON Imaging Manifest (see Section 6.2)

Add Section 6.2

6.2 JSON Imaging Manifest

6.2.1 Scope

The JSON Imaging Manifest defines the content retrieval locations for an imaging study (performed procedure) necessary for a consumer to retrieve content from a provider of DICOM instances. This manifest may be derived from an XDS-I Manifest document, which is a DICOM KOS object. The JSON Imaging Manifest is a simple JavaScript Object Notation (JSON) object to represent this information in a concise, hierarchical manner. It provides the Study, Series, and SOP Instance UIDs, SOP Class UID, and repositoryUniqueId.

6.2.2 Referenced Standards

IETF RFC2616 HyperText Transfer Protocol HTTP/1.1

IETF RFC4627 The application/json Media Type for JavaScript Object Notation (JSON)

DICOM PS3.18: Web Services

6.2.3 Message Semantics

The JSON Imaging Manifest shall be expressed in JavaScript Object Notation (JSON), using the UTF-8 character set.

The JSON Imaging Manifest shall contain URLs to retrieve DICOM instances using WADO-URI. If the WADO-RS Option is supported, the JSON Imaging Manifest shall also contain URLs to retrieve DICOM instances using WADO-RS.

All attribute values that are not objects or arrays shall be represented as strings.

The media type for this content type is “application/json”.

The content shall be expressed according to Table 6.2.3-1.

In Table 6.2.3-1, the R in the Optionality column indicates that the attribute shall be sent with a non-empty value, and C indicates that the attribute shall be sent with a non-empty value if the WADO-RS Option is supported.

Table 6.2.3-1: JSON Imaging Manifest structure

Entity	Attribute	Description	Optionality
root	resourceType	Shall be “ImagingManifest”	R
	study	Array of study objects	R
Study	uid	Study Instance UID, prefixed by “urn:oid:”	R
	series	Array of series objects	R
	url	WADO-RS URL reference	C
Series	uid	Series Instance UID, prefixed by “urn:oid:”	R
	instance	Array of instance objects	R
	url	WADO-RS URL reference	C
Instance	uid	SOP Instance UID, prefixed by “urn:oid:”	R
	sopClass	SOP Class UID, prefixed by “urn:oid:”	R
	url	WADO-RS URL reference	R
	urlWadoUri	WADO-URI URL reference, with a contentType of “application/dicom”	C

6.2.3.1 Example with WADO-URI URLs

```
{
    "resourceType": "ImagingManifest",
    "study": [
        {
            "uid": "urn:oid:1.2.250.1.59.40211.12345678.678910",
            "series": [
                {
                    "uid": "urn:oid:1.2.250.1.59.14556172.67789",
                    "instance": [
                        {
                            "uid":
"urn:oid:1.2.250.1.59.40211.2678810.87991027.899772.2",
                            "urlWadoUri":
"https://www.hospital.com/radiology/wado/?requestType=WADO&studyUID=1.2.250.1
.59.40211.12345678.678910&seriesUID=1.2.250.1.59.14556172.67789&objectUID=1.2
.250.1.59.40211.2678810.87991027.899772.2&contentType=application%2Fdicom",
                            "sopClass": "urn:oid:1.2.840.10008.5.1.4.1.1.2"
                        }
                    ]
                }
            ]
        }
    ]
}
```


6.2.3.2 Example with WADO-URI and WADO-RS URLs using the WADO-RS Option

```
{
    "resourceType": "ImagingManifest",
    "study": [
        {
            "uid": "urn:oid:1.2.250.1.59.40211.12345678.678910",
            "url":
"https://radiology.hospital.com/studies/1.2.250.1.59.40211.12345678.678910",
            "series": [
                {
                    "uid": "urn:oid:1.2.250.1.59.14556172.67789",
                    "url":
"https://radiology.hospital.com/studies/1.2.250.1.59.40211.12345678.678910/se
ries/1.2.250.1.59.14556172.67789",
                    "instance": [
                        {
                            "uid":
"urn:oid:1.2.250.1.59.40211.2678810.87991027.899772.2",
                            "url":
"https://radiology.hospital.com/studies/1.2.250.1.59.40211.12345678.678910/se
ries/1.2.250.1.59.14556172.67789/instances/1.2.250.1.59.40211.2678810.8799102
7.899772.2",
                            "urlWadoUri": "https://radiology.hospital.com/
wado/?requestType=WADO&studyUID=1.2.250.1.59.40211.12345678.678910&seriesUID=
1.2.250.1.59.14556172.67789&objectUID=1.2.250.1.59.40211.2678810.87991027.899
772.2&contentType=application%2Fdicom",
                            "sopClass": "urn:oid:1.2.840.10008.5.1.4.1.1.2"
                        }
                    ]
                }
            ]
        }
    ]
}
```

Add the following row to RAD TF-3: Table 5.1-2

Table 5.1-2: IHE Radiology transactions and resulting ATNA trigger events

IHE Radiology Transaction	ATNA Trigger Event(s)	Actor(s) that shall be able to record audit event
Patient Registration [RAD-1]	Patient-record-event	ADT Order Placer, DSS/OF – when PHI is presented
…		
WADO-RS Retrieve [RAD-107]	**Instance-Stored**	**Imaging Document Source**

Appendices

Add to Appendix G

G.X: Mapping DICOM AE Title or Retrieve Location UID to WADO-RS

To use the WADO-RS Retrieve [RAD-107] transaction to retrieve DICOM instances referenced within a manifest document, an Imaging Document Consumer must know the base URL (location) for the WADO-RS service. This may be a combination of protocol (either http or https), host, port, and application (e.g., http://wado.ihe.net/wado-rs).

The Imaging Document Consumer needs to maintain a list that associates the base URL of all WADO-RS Imaging Document Sources in the XDS Affinity Domain and their Retrieve AE Titles and/or Retrieve Location UIDs. Using this mapping, the Retrieve AE Title or Retrieve Location UID of a referenced SOP instance in the manifest can be translated to a base URL, which is then passed in the WADO-RS request together with a Study Instance UID (and other optional SOP instance identification information).

To achieve an unambiguous, automated mapping from Retrieve AE Title to a web service address, some policy needs to be in place to ensure unique Retrieve AE Titles of Imaging Document Sources within the entire XDS Affinity Domain.

Add Appendix X

Appendix X – MHD-I Examples (Informative)

This appendix contains examples of the Mobile access to Health Documents for Imaging transactions, and is informative only.

X.1 Study Selection and Retrieval Examples

The following examples illustrate MHD-I Use Case #1 described in RAD TF-1: 36.4.2.1, the four-step process to go from discovering available studies to retrieving individual instances.

These examples are not fully populated; for example, the HTTP headers are not meant to be a full enumeration of the possible HTTP headers.

Given the patient ID, the radiologist wants to discover what procedures are available. His EMR client supplies the appropriate patient identifier to query on. Throughout this example, the patient identifier value is “144” with the issuer of “1.3.6.1.4.1.21367.2005.3.7”.

X.1.1 Retrieve List of Dossiers using Find Document Dossiers [ITI-67]

Given the patient ID, the first step for the client is to request the available dossiers for this patient, using the Find Document Dossiers [ITI-67] transaction, constrained to manifests (using the formatCode parameter):


```
GET
https://xds.hospital.com/net.ihe/DocumentDossier/search?PatientID=144%5E%5E%5
E%261.3.6.1.4.1.21367.2005.3.7%26ISO&formatCode=
urn:ihe:rad:jsonimagingmanifest HTTP/1.1
Accept: application/json
```

The response is as follows:

```
HTTP/1.1 200 OK
Content-Type: application/json

{
    "updated": "201402110900",
    "self":
"https://xds.hospital.com/net.ihe/DocumentDossier/search?PatientID=144%5E%5E%
5E%261.3.6.1.4.1.21367.2005.3.7%26ISO&formatCode=urn:ihe:rad:jsonimagingmanif
est",
    "entries": [
        {
            "id": "urn:uuid:14a9fdec-0af4-45bb-adf2-d752b49bcc7d",
            "self":
"https://xds.hospital.com/net.ihe/DocumentDossier/14a9fdec-0af4-45bb-adf2-
d752b49bcc7d?PatientID=144%5E%5E%5E%261.3.6.1.4.1.21367.2005.3.7%26ISO",
            "related": "https://xds.hospital.com/net.ihe/Document/14a9fdec-
0af4-45bb-adf2-
d752b49bcc7d/?PatientID=144%5E%5E%5E%261.3.6.1.4.1.21367.2005.3.7%26ISO",
            "updated": "201308170900"
        },
        {
            "id": "urn:uuid:22222222-0af4-45bb-adf2-d752b49bcc7d",
            "self":
"https://xds.hospital.com/net.ihe/DocumentDossier/22222222-0af4-45bb-adf2-
d752b49bcc7d?PatientID=144%5E%5E%5E%261.3.6.1.4.1.21367.2005.3.7%26ISO",
            "related": "https://xds.hospital.com/net.ihe/Document/22222222-
0af4-45bb-adf2-
d752b49bcc7d/?PatientID=144%5E%5E%5E%261.3.6.1.4.1.21367.2005.3.7%26ISO",
            "updated": "201111170900"
        }
    ]
}
```

This response indicates that there are likely two procedures available for this patient, one in August 17, 2013, and the other November 17, 2011.

X.1.2 Retrieve Dossier Metadata Using Get Document Dossier [ITI-66]

Now that the client has the list of dossiers, it needs to obtain relevant information about each dossier to provide to the radiologist, to enable him to select the most appropriate one to open. The URL to retrieve the dossier is available in the Find Document Dossiers response, using the "self" attribute. Each dossier needs to be retrieved to provide enough information for the radiologist to select a procedure. The first dossier request is as follows:


```
GET https://xds.hospital.com/net.ihe/DocumentDossier/14a9fdec-0af4-45bb-adf2-
d752b49bcc7d?PatientID=144%5E%5E%5E%261.3.6.1.4.1.21367.2005.3.7%26ISO
HTTP/1.1
Accept: application/json
```

The response is as follows:

```
HTTP/1.1 200 OK
Content-Type: application/json

{
    "documentEntry": {
        "author" : {
            "authorInstitution" : "General
Hospital^^^^^^^^^^1.2.3.4.5.6.7.8.9.1789.45",
            "authorPerson" : "^Welby^Marcus^^^Dr^MD",
            "authorRole" : "Radiologist",
            "authorSpecialty":"Neuroradiology"
        },
        "availabilityStatus": "urn:oasis:names:tc:ebxml-
regrep:StatusType:Approved",
        "classCode": {
            "code": "18726-0",
            "codingScheme": "2.16.840.1.113883.6.1",
            "codeName": "Radiology Studies (Set)"
        },
        "comments": "None",
        "confidentialityCode": {
            "code": "N",
            "codingScheme": "urn:oid:2.16.840.1.113883.5.25",
            "codeName": "normal"
        },
        "creationTime": "201308170900",
        "entryUUID": "urn:uuid:14a9fdec-0af4-45bb-adf2-d752b49bcc7d",
        "eventCodeList": [
            {
                "code": "CT",
                "codingScheme": "DCM",
                "codeName": "Computed Tomography"
            },
            {
                "code": "T-D1100",
                "codingScheme": "SRT",
                "codeName": "Head"
            }
        ],
        "formatCode": {
            "code": "urn:ihe:rad:jsonimagingmanifest",
            "codingScheme": "urn:ihe:rad:xdsi-b:2009",
            "codeName": "JSON Imaging Manifest"
        },
        "hash": "e543712c0e10501972de13a5bfcbe826c49feb75",
```



```
        "healthcareFacilityTypeCode": {
            "code": "1.2.3.4.5.6.7.8.9.1789.45",
            "codingScheme": "urn:oid:1.2.3.4.5.6.7.8.9.1789",
            "codeName": "General Hospital"
        },
        "homeCommunityId": "urn:oid:1.2.3.4.5.6.7.8.9.1789.45",
        "languageCode": "en-CA",
        "legalAuthenticator" : "^Welby^Marcus^^^Dr^MD",
        "mimeType": "application/json",
        "patientID": "144^^^&1.3.6.1.4.1.21367.2005.3.7&ISO",
        "practiceSettingCode": {
            "code": "R-3027B",
            "codingScheme": "SRT",
            "codeName": "Radiology"
        },
        "referenceIdList":
["12345^^^&1.3.6.1.4.1.21367.2005.3.8&ISO^urn:ihe:iti:2013:accession"],
        "repositoryUniqueId": "urn:oid:1.2009.123",
        "serviceStartTime": "201308170900",
        "serviceStopTime": "201308170920",
        "size": "350",
        "sourcePatientId": "144^^^&1.3.6.1.4.1.21367.2005.3.7&ISO",
        "sourcePatientInfo": ["144^^^&1.3.6.1.4.1.21367.2005.3.7&ISO"],
        "title": "Manifest",
        "typeCode": {
            "code": "30799-1",
            "codingScheme": "2.16.840.1.113883.6.1",
            "codeName": "Head CT WO contrast"
        },
        "uniqueId": "urn:oid:1.2009.0827.08.33.5074"
    }
}
```

This response has returned information about the first dossier; i.e., it is a head CT procedure performed on August 17, 2013 at General Hospital by Dr. Marcus Welby as accession 12345.

An additional request retrieves a dossier about a second procedure.

X.1.3 Retrieve Procedures Performed Structure Using Get Document [ITI-68]

Now that the client has specific details about the procedures performed on the patient, it presents this list to the radiologist. The radiologist selects the first procedure. In order to retrieve the associated images, the client must obtain the instance structure by retrieving the JSON Imaging Manifest. The URL to retrieve the JSON Imaging Manifest is available in the Find Document Dossiers response, using the “related” attribute.

The client makes the following request:

```
GET https://xds.hospital.com/net.ihe/Document/14a9fdec-0af4-45bb-adf2-
d752b49bcc7d/?PatientID=144%5E%5E%5E%261.3.6.1.4.1.21367.2005.3.7%26ISO
HTTP/1.1
Accept: application/json
```


The response from this query is as follows:

```
HTTP/1.1 200 OK
Content-Type: application/json

{
    "resourceType": "ImagingManifest",
    "study": [
        {
            "uid": "urn:oid:1.2.250.1.59.40211.12345678.678910",
            "url":
"https://radiology.hospital.com/studies/1.2.250.1.59.40211.12345678.678910",
            "series": [
                {
                    "uid": "urn:oid:1.2.250.1.59.14556172.67789",
                    "url":
"https://radiology.hospital.com/studies/1.2.250.1.59.40211.12345678.678910/se
ries/1.2.250.1.59.14556172.67789",
                    "instance": [
                        {
                            "uid":
"urn:oid:1.2.250.1.59.40211.2678810.87991027.899772.2",
                            "url": "https://radiology.hospital.com/studies/
1.2.250.1.59.40211.12345678.678910/series/1.2.250.1.59.14556172.67789/instanc
es/1.2.250.1.59.40211.2678810.87991027.899772.2",
                            "urlWadoUri":
"https://radiology.hospital.com/wado/
?requestType=WADO&studyUID=1.2.250.1.59.40211.12345678.678910&seriesUID=1.2.2
50.1.59.14556172.67789&objectUID=
1.2.250.1.59.40211.2678810.87991027.899772.2&contentType=application%2Fdicom"
,
                            "sopClass": "urn:oid:1.2.840.10008.5.1.4.1.1.2"
                        },
                        {
                            // additional instances here
                        }
                    ]
                },
                {
                    // additional series here
                }
            ]
        }
        // no additional studies in this example
    ]
}
```

Note: If the Document Responder does not support the WADO-RS Option, the “url” attributes would not be present.

This response has returned information about the first procedure’s structure, including one Series and one SOP Instance. Other instances and series are omitted for brevity.

X.1.4 Retrieve DICOM Instances

The client has the study structure, and can retrieve the specific instances for rendering to the radiologist, based on the URLs available in the JSON Imaging Manifest.

The client can retrieve the instances by using the URL in the WADO-URI attribute (in the "urlWadoUri"), or, if available, by using the URL in the WADO-RS attribute ("url"). In the content below, the WADO [RAD-55] example provides a response for a single instance in JPEG, whereas the WADO-RS [RAD-107] example provides a response for an entire series in native DICOM.

X.1.4.1 Retrieve DICOM Instances with WADO [RAD-55]

The client extracts the URL for the first image from the JSON Imaging Manifest and adjusts the appropriate parameters for its desired response. In order to change the content type of the request, the contentType parameter has been re-written by the client.

This results in the following URL:

```
GET
https://www.hospital.com/radiology/wado/?requestType=WADO&studyUID=1.2.250.1.
59.40211.12345678.678910&seriesUID=1.2.250.1.59.14556172.67789&objectUID=1.2.
250.1.59.40211.2678810.87991027.899772.2&contentType=image%2Fjpeg HTTP/1.1
Accept: image/jpeg
```

The response from this query is:

```
HTTP/1.1 200 OK
Content-Type: image/jpeg

<binary image data>
```

Each additional image would have to be retrieved with a separate request.

X.1.4.2 Retrieve DICOM Instances with WADO-RS [RAD-107]

The client extracts the URL for the first series from the JSON Imaging Manifest, resulting in the following:

```
GET https://radiology.hospital.com/studies/
1.2.250.1.59.40211.12345678.678910/series/1.2.250.1.59.14556172.67789
HTTP/1.1
Accept: multipart/related; type=application/dicom
```

The response from this query is:

```
HTTP/1.1 200 OK
Content-Type: multipart/related; type=application/dicom;
boundary=MESSAGEBOUNDARY

--MESSAGEBOUNDARY
Content-Type: application/dicom
```



```
<binary data>

--MESSAGEBOUNDARY
Content-Type: application/dicom

<binary data>

--MESSAGEBOUNDARY--
```

X.2 Instance Metadata Retrieval

The following is an example of using WADO-RS to retrieve DICOM headers for further processing and determining additional retrievals to perform.

The examples illustrate MHD-I Use Case #2 described in RAD TF-1: 36.4.2.2. The examples are not fully populated; i.e., some DICOM headers are excluded for brevity.

For this example, the URL of the study resource has previously been extracted from the JSON Imaging Manifest; see the example in X.1. With this URL the client can obtain instance metadata to enable it to determine what instances to retrieve.

WADO Retrieve [RAD-55] cannot be used in this use case because it does not support retrieving metadata.

X.2.1 Get Metadata via WADO-RS Retrieve [RAD-107]

The client makes a request by taking the URL of the study resource and appending the suffix "/metadata". The following two examples demonstrate providing alternate Accept headers.

X.2.1.1 Retrieve Metadata as Native DICOM Model XML

The following query is made, with the Accept header to request "application/dicom+xml":

```
GET https://radiology.hospital.com/studies/
1.2.250.1.59.40211.12345678.678910/metadata HTTP/1.1
Accept: multipart/related; type=application/dicom+xml
```

The response from this query is:

```
HTTP/1.1 200 OK
Content-Type: multipart/related; type=application/dicom+xml;
boundary=MESSAGEBOUNDARY

--MESSAGEBOUNDARY
Content-Type: application/dicom+xml

<?xml version="1.0" encoding="UTF-8" space="preserve"?>

<NativeDicomModel xmlns="http://dicom.nema.org/PS3.19/models/NativeDICOM"
xsi:schemaLocation="http://dicom.nema.org/PS3.19/models/NativeDICOM"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
   <DicomAttribute tag="00080008" vr="CS" keyword="ImageType">
```



```
      <Value number="1">ORIGINAL</Value>
      <Value number="2">PRIMARY</Value>
      <Value number="3">AXIAL</Value>
      <Value number="4">HELIX</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080012" vr="DA" keyword="InstanceCreationDate">
      <Value number="1">20130817</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080013" vr="TM" keyword="InstanceCreationTime">
      <Value number="1">090000.000000</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080016" vr="UI" keyword="SOPClassUID">
      <Value number="1">1.2.840.10008.5.1.4.1.1.2</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080018" vr="UI" keyword="SOPInstanceUID">
      <Value number="1">1.2.250.1.59.40211.2678810.87991027.899772.2</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080020" vr="DA" keyword="StudyDate">
      <Value number="1">20130817</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080022" vr="DA" keyword="AcquisitionDate">
      <Value number="1">20130817</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080030" vr="TM" keyword="StudyTime">
      <Value number="1">090000.000000</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080032" vr="TM" keyword="AcquisitionTime">
      <Value number="1">090000.000000</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080050" vr="SH" keyword="AccessionNumber">
      <Value number="1">12345</Value>
   </DicomAttribute>
   <DicomAttribute tag="00080060" vr="CS" keyword="Modality">
      <Value number="1">CT</Value>
   </DicomAttribute>
   <DicomAttribute tag="00081030" vr="LO" keyword="StudyDescription">
      <Value number="1">CT HEAD WO CONTRAST</Value>
   </DicomAttribute>
   <DicomAttribute tag="0008103E" vr="LO" keyword="SeriesDescription">
      <Value number="1">Series 1</Value>
   </DicomAttribute>
   <DicomAttribute tag="00100010" vr="PN" keyword="PatientName">
      <PersonName number="1">
         <Alphabetic>
            <FamilyName>WANG</FamilyName>
            <GivenName>XIAODONG</GivenName>
         </Alphabetic>
      </PersonName>
   </DicomAttribute>
   <DicomAttribute tag="00100020" vr="LO" keyword="PatientID">
      <Value number="1">144</Value>
   </DicomAttribute>
```



```
   <DicomAttribute tag="00100021" vr="LO" keyword="IssuerOfPatientID">
      <Value number="1">1.3.6.1.4.1.21367.2005.3.7</Value>
   </DicomAttribute>
   <DicomAttribute tag="00100040" vr="CS" keyword="PatientSex">
      <Value number="1">M</Value>
   </DicomAttribute>
   <DicomAttribute tag="0020000D" vr="UI" keyword="StudyInstanceUID">
      <Value number="1">1.2.250.1.59.40211.12345678.678910</Value>
   </DicomAttribute>
   <DicomAttribute tag="0020000E" vr="UI" keyword="SeriesInstanceUID">
      <Value number="1">1.2.250.1.59.14556172.67789</Value>
   </DicomAttribute>
   <DicomAttribute tag="00200011" vr="IS" keyword="SeriesNumber">
      <Value number="1">1</Value>
   </DicomAttribute>
   <DicomAttribute tag="00200013" vr="IS" keyword="InstanceNumber">
      <Value number="1">1</Value>
   </DicomAttribute>
   <DicomAttribute tag="00280002" vr="US" keyword="SamplesPerPixel">
      <Value number="1">1</Value>
   </DicomAttribute>
   <DicomAttribute tag="00280004" vr="CS"
keyword="PhotometricInterpretation">
      <Value number="1">MONOCHROME2</Value>
   </DicomAttribute>
   <DicomAttribute tag="00280010" vr="US" keyword="Rows">
      <Value number="1">512</Value>
   </DicomAttribute>
   <DicomAttribute tag="00280011" vr="US" keyword="Columns">
      <Value number="1">512</Value>
   </DicomAttribute>
   <DicomAttribute tag="00280100" vr="US" keyword="BitsAllocated">
      <Value number="1">16</Value>
   </DicomAttribute>
   <DicomAttribute tag="00280101" vr="US" keyword="BitsStored">
      <Value number="1">12</Value>
   </DicomAttribute>
   <DicomAttribute tag="00180050" vr="DS" keyword="SliceThickness">
      <Value number="1">0.8</Value>
   </DicomAttribute>
   <DicomAttribute tag="00185100" vr="DS" keyword="PatientPosition">
      <Value number="1">HFS</Value>
   </DicomAttribute>
</NativeDicomModel>

--MESSAGEBOUNDARY
Content-Type: application/dicom+xml

<!-- additional instances -->

--MESSAGEBOUNDARY—
```


In the above response, the DICOM headers have been returned.

For this example, only one instance response is shown; for each additional instance in the study, there will be additional parts (as shown by the <!-- additional instances --> comment). Also, some DICOM tags in this response have been omitted in this example for brevity.

X.2.1.2 Retrieve Metadata as DICOM JSON Model

The following query is made, with the Accept header to request “application/json”:

```
GET https://radiology.hospital.com/studies/
1.2.250.1.59.40211.12345678.678910/metadata HTTP/1.1
Accept: application/json
```

The response from this query is:

```
HTTP/1.1 200 OK
Content-Type: application/json

[
  {
    "00080008": {
        "vr": "CS",
        "Value": [
            "ORIGINAL",
            "PRIMARY",
            "AXIAL",
            "HELIX"
        ]
    },
    "00080012": {
        "vr": "DA",
        "Value": [
            "20130817"
        ]
    },
    "00080013": {
        "vr": "TM",
        "Value": [
            "090000.000000"
        ]
    },
    "00080016": {
        "vr": "UI",
        "Value": [
            "1.2.840.10008.5.1.4.1.1.2"
        ]
    },
    "00080018": {
        "vr": "UI",
        "Value": [
```



```
            "1.2.250.1.59.40211.2678810.87991027.899772.2"
        ]
    },
    "00080020": {
        "vr": "DA",
        "Value": [
            "20130817"
        ]
    },
    "00080022": {
        "vr": "DA",
        "Value": [
            "20130817"
        ]
    },
    "00080030": {
        "vr": "TM",
        "Value": [
            "090000.000000"
        ]
    },
    "00080032": {
        "vr": "TM",
        "Value": [
            "090000.000000"
        ]
    },
    "00080050": {
        "vr": "SH",
        "Value": [
            "12345"
        ]
    },
    "00080060": {
        "vr": "CS",
        "Value": [
            "CT"
        ]
    },
    "00081030": {
        "vr": "LO",
        "Value": [
            "CT HEAD WO CONTRAST"
        ]
    },
    "0008103E": {
        "vr": "LO",
        "Value": [
            "Series 1"
        ]
    },
    "00100010": {
```



```
        "vr": "PN",
        "Value": [
            {
                "Alphabetic": {
                    "Family": [
                        "Wang"
                    ],
                    "Given": [
                        "XiaoDong"
                    ]
                }
            }
        ]
    },
    "00100020": {
        "vr": "LO",
        "Value": [
            "144"
        ]
    },
    "00100021": {
        "vr": "LO",
        "Value": [
            "1.3.6.1.4.1.21367.2005.3.7"
        ]
    },
    "00100040": {
        "vr": "CS",
        "Value": [
            "M"
        ]
    },
    "0020000D": {
        "vr": "UI",
        "Value": [
            "1.2.250.1.59.40211.12345678.678910"
        ]
    },
    "0020000E": {
        "vr": "UI",
        "Value": [
            "1.2.250.1.59.14556172.67789"
        ]
    },
    "00200011": {
        "vr": "IS",
        "Value": [
            1
        ]
    },
    "00200013": {
        "vr": "IS",
```



```
        "Value": [
            1
        ]
    },
    "00280002": {
        "vr": "US",
        "Value": [
            1
        ]
    },
    "00280004": {
        "vr": "CS",
        "Value": [
            "MONOCHROME2"
        ]
    },
    "00280010": {
        "vr": "US",
        "Value": [
            512
        ]
    },
    "00280011": {
        "vr": "US",
        "Value": [
            512
        ]
    },
    "00280100": {
        "vr": "US",
        "Value": [
            16
        ]
    },
    "00280101": {
        "vr": "US",
        "Value": [
            12
        ]
    },
    "00180050": {
        "vr": "DS",
        "Value": [
            0.8
        ]
    },
    "00185100": {
        "vr": "DS",
        "Value": [
            "HFS"
        ]
    }
```



```
  }
  // additional instances
]
```

In the above response, the DICOM headers have been returned.

For this example, only one instance response is shown; for each additional instance in the study, there will be additional parts (as shown by the "// additional instances" comment). Also, some DICOM tags in this response have been omitted in this example for brevity.

X.2.2 Parse Metadata

The DICOM instance metadata is parsed by the client to determine which SOP Instances to request from the server, using fields such as slice thickness and patient position.

X.2.3 Retrieve DICOM Instances with WADO-RS [RAD-107]

The client assembles the appropriate WADO-RS request using the information obtained from the metadata and the manifest. The client then retrieves the subset of SOP Instances using WADO-RS [RAD-107]. Each instance requires a separate request, as follows:

```
GET
https://radiology.hospital.com/studies/1.2.250.1.59.40211.12345678.678910/ser
ies/1.2.250.1.59.14556172.67789/instances/1.2.250.1.59.40211.2678810.87991027
.899772.2 HTTP/1.1
Accept: multipart/related; type=application/dicom
```

The response from this query is to return the requested instance:

```
HTTP/1.1 200 OK
Content-Type: multipart/related; type=application/dicom;
boundary=MESSAGEBOUNDARY

--MESSAGEBOUNDARY
Content-Type: application/dicom

<binary data>

--MESSAGEBOUNDARY--
```

Note: The retrieval of the instances could also be done via WADO Retrieve [RAD-55], since fully qualified WADO-URI references are present in the manifest.

X.3 Key Image Example

This example illustrates MHD-I Use Case #3 described in RAD TF-1: 36.4.2.3. It demonstrates an example of using WADO Retrieve [RAD-55] to retrieve the Key Image Note for targeted retrieval of instances. This example does not show a WADO-RS Retrieve [RAD-107], but it is allowed if the WADO-RS Option is supported by both actors.

For this example, the JSON Imaging Manifest has been previously retrieved; presumably, this occurred by following similar steps in the example in X.1, but for a different patient and set of resulting procedures. A procedure was selected, and the JSON Imaging Manifest is as follows:

```
{
    "resourceType": "ImagingManifest",
    "study": [
        {
            "uid": "urn:oid:1.2.250.1.59.12345678",
            "series": [
                {
                    "uid": "urn:oid:1.2.250.1.60.12345678.1",
                    "instance": [
                        {
                            "uid": "urn:oid:1.2.250.1.61.12345678",
                            "urlWadoUri":
"https://radiology.hospital.com/wado/?requestType=WADO&studyUID=1.2.250.1.59.
12345678&seriesUID=1.2.250.1.60.12345678&objectUID=1.2.250.1.61.12345678",
                            "sopClass":
"urn:oid:1.2.840.10008.5.1.4.1.1.88.59"
                        }
                    ],
                },
                {
                    "uid": "urn:oid:1.2.250.1.60.12345678.2",
                    "instance": [
                        {
                            "uid": "urn:oid:1.2.250.1.61.12345679",
                            "urlWadoUri":
"https://radiology.hospital.com/wado/?requestType=WADO&studyUID=1.2.250.1.59.
12345678&seriesUID=1.2.250.1.60.12345678&objectUID=1.2.250.1.61.12345679",
                            "sopClass": "urn:oid: 1.2.840.10008.5.1.4.1.1.2.1"
                        },
                        {
                            // additional instances
                        }
                    ]
                }
            ]
        }
    ]
}
```

Note: This example is not fully populated; i.e., in a real world case, additional series and instances are likely to be present.

In this JSON Imaging Manifest, there are two series: a Key Object Selection series, and a CT Image series with multiple images. This is apparent from the sopClass attribute.

Note: In this example, assuming that it claims support of the Image Display Actor in the IHE Radiology Key Image Note (KIN) Profile, the text in the KOS Document Title must be displayed to the user.

X.3.1 Parse JSON Imaging Manifest

The client needs to find the Key Image Note to determine what images to display. It parses the JSON to find all sopClass attributes that match “1.2.840.10008.5.1.4.1.1.88.59”.

X.3.2 Retrieve Key Image Note

Finding only one Key Object Selection (KOS) reference, the client retrieves the KOS document to determine from its title, if it is appropriate to use.

The client retrieves the KOS instance:

```
GET
https://radiology.hospital.com/wado/?requestType=WADO&studyUID=1.2.250.1.59.
12345678&seriesUID=1.2.250.1.59.12345678.1&objectUID=1.2.250.1.59.12345678.1.
1&contentType=application%2Fdicom HTTP/1.1
Accept: application/dicom
```

The response from this request is:

```
HTTP/1.1 200 OK
Content-Type: application/dicom

<binary KOS data>
```

The client understands how to parse the DICOM binary KOS instance.

It finds the Document Title of (113002, DCM, “For Referring Provider”). The KOS document contains the SOP Instance UIDs of the images to retrieve.

X.3.3 Retrieve Images

The contents of the KOS identify the specific SOP Instance UIDs to retrieve. The client retrieves the images from the Imaging Document Source. The client retrieves the images, as described in X.1.4, and displays them.

