



Nationwide Health Information Network (NHIN)

Retrieve Documents

Web Service Interface Specification

V 2.0

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1 Preface

1.1 Introduction

The Nationwide Health Information Network (NHIN) Web Service Interface specifications define the core set of standard services to be implemented by each node on the NHIN network in order exchange interoperable health information over the Internet. Health Information Organizations (HIOs) which act as nodes on the NHIN are termed NHIOs. These functional services provide discovery and information exchange capabilities and rest upon a foundational set of messaging, security, and privacy services.

This document presents the NHIN Retrieve Documents Web Service Interface specification. Together with the Query for Documents Service Interface specification, Retrieve Documents enables the NHIN's Query/Retrieve information exchange pattern.

1.2 Intended Audience

The primary audiences for NHIN Specifications are the individuals responsible for implementing software solutions that realize these interfaces at Health Information Organizations (HIOs) who are, or seek to be, nodes on the NHIN network. This specification document is intended to provide an understanding of the context in which the web service interface is meant to be used, the behavior of the interface, the Web Services Description Language (WSDLs) used to define the service, and any Extensible Markup Language (XML) schemas used to define the content.

1.3 Business Needs Supported by this Specification

Retrieve documents is the third in the three-step process which defines the Query/Retrieve information exchange pattern in the NHIN:

- 1) Arbitrate patient identity
- 2) Query for list of available documents
- 3) Retrieve documents

1.4 Referenced Documents and Standards

The following documents and standards were referenced during the development of this specification. Specific deviations from or constraints upon these standards are identified below.

- 1) **Org/SDO name:** HITSP

Reference # / Spec Name: TP13 / Manage Sharing of Documents Transaction Package

Version #: v2.6

Underlying Specs:

- IHE ITI TF Supplement XCA TI (2009-8-10)
- IHE ITI TF Vol. 1 & 2a, 2b, 2x, 3 Revision 6.0 (2009-8-10)

NHIN Deviations or Constraints:

Link:

http://www.hitsp.org/ConstructSet_Details.aspx?&PrefixAlpha=2&PrefixNumeric=13

- 2) **Org/SDO name:** HITSP

Reference # / Spec Name: C80/ Clinical Document and Message Terminology Component



Version #: v1.2

NHIN Deviations or Constraints:

Underlying Specs:

Link:

http://www.hitsp.org/ConstructSet_Details.aspx?&PrefixAlpha=4&PrefixNumeric=80

3) **Org/SDO name:** IHE

Reference # / Spec Name: ITI TF Supplement XCA TI

Version #: 2009-8-10

NHIN Deviations or Constraints:

Underlying Specs:

Link:

http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_Supplement_Cross_Community_Access_XCA_TI_2009-08-10.pdf

Change Proposals Adopted by NHIN:

- a. **Change Proposal Name:** IHE Change Proposal 420

Change Proposal Description: Updates XCA to use a single Action value for both synchronous and asynchronous interactions. This balloted and approved Change Proposal will integrate into the XCA Supplement in August 2010 and is adopted by the NHIN now because of its importance.

Change Proposal Link: ftp://ftp.ihe.net/IT_Infrastructure/TF_Maintenance-2009/CPs/FinalText/CP-ITI-420-FT.doc

4) **Org/SDO name:** IHE

Reference # / Spec Name: ITI TF Vol. 1 & 2a, 2b, 2x, 3

Version #: Revision 6.0 (2009-8-10)

NHIN Deviations or Constraints:

Underlying Specs:

Links:

- http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol1_FT_2009-08-10-2.pdf
- http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol2a_FT_2009-08-10-2.pdf
- http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol2b_FT_2009-08-10.pdf
- http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol2x_FT_2009-08-10.pdf
- http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol3_FT_2009-08-10-2.pdf

5) **Org/SDO name:** OASIS

Reference # / Spec Name: ebRIM: OASIS/ebXML Registry Information Model

Version #: v 3.0

NHIN Deviations or Constraints:



Underlying Specs:

Link:

<http://docs.oasis-open.org/regrep/v3.0/specs/regrep-rim-3.0-os.pdf>

6) **Org/SDO name:** OASIS

Reference # / Spec Name: ebRS: OASIS/ebXML Registry Services Specifications

Version #: v 3.0

NHIN Deviations or Constraints:

Underlying Specs:

Link:

<http://docs.oasis-open.org/regrep/v3.0/specs/regrep-rs-3.0-os.pdf>

1.5 Relationship to Other NHIN Specifications

This specification is related to other NHIN specifications as described below:

- **Messaging Platform** – specifies a base set of messaging standards and web service protocols which must be implemented by each NHIN node and applies to all transactions. All NHIN inter-nodal messages are SOAP messages over HTTP using web services, must be encrypted and digitally signed.
- **Authorization Framework** – defines the exchange of metadata used to characterize each NHIN request. The purpose of that exchange is to provide the responder with the information needed to make an authorization decision for the requested function. Each initiating message must convey information regarding end user attributes and authentication using SAML 2.0 assertions.

Together, the Messaging Platform and the Authorization Framework define the foundational messaging, security and privacy mechanisms for the NHIN.

- **Patient Discovery** – defines the mechanism by which one NHIN node can query another to reciprocally establish patient identity and to determine if a node may be a source of information for a specific patient. It represents the first of three steps in the typical NHIN Query/Retrieve information exchange pattern.
- **Query for Documents** – allows an initiating node to request a patient-specific list of available documents from a responding node using the Patient ID obtained via a prior Patient Discovery transaction. It represents the second of three steps in the typical NHIN Query/Retrieve information exchange pattern.
- **Web Services Registry** – enables nodes to discover each other through interactions with the NHIN UDDI registry, which lists NHIN nodes, the NHIN web services supported by each node, and how to reach those service end points. In this context, it might be needed to identify target nodes

2 Interface Description

2.1 Definition

A request initiated from one NHIO to another, seeking to retrieve specific documents presumably identified by a prior Query for Documents.



In this Interface definition, a “document” refers to the form of clinical data as it is transferred between NHIOs, not as it is stored in an NHIO. Any HIO may store clinical data in whatever format or repository it chooses, so long as the NHIO can respond to queries as described in this interface, and respond to “retrieve document” requests as described in the “Retrieve Documents Service Interface specification”¹. Specifically, a “document” transferred between NHIOs need not meet the criteria for persistence, stewardship, etc. as identified by the HL7 Structured Documents committee.

The primary assumption in the context of the NHIN is that documents are formatted as XML data following the HL7 Clinical Document Architecture (CDA) standard, but nothing precludes this interface from being used to query for other kinds of documents, such as Adobe Portable Document Format files or images.

2.2 Design Principles and Assumptions

The following assumptions or design principles underlie this specification:

- A NHIO may have obtained a Document ID to be used for Retrieval as detailed in the Query Documents specification or by some other mechanism.
- Responding NHIOs will return the specified documents subject to an authorization decision which evaluates the request against local consumer preferences and local policies and permissions.

2.3 Triggers

After obtaining one or more Document IDs, presumably in the list of available documents returned in a prior Query for Documents transaction, an NHIO edge system submits a retrieve documents request to its NHIO’s NHIN Gateway (the format of that request is outside the scope of this specification). In turn, the NHIN Gateway sends a Retrieve Documents request in the specified format to the NHIN Gateway specified in the metadata associated the Document ID(s) – specifically to the service endpoint as identified in the NHIN service registry. For further details regarding retrieve parameters and metadata, see section 3.3 “Retrieve Parameters”.

2.4 Transaction Standard

NHIN Retrieve Documents utilizes the IHE Cross Community Access (XCA) ITI-39: Cross Gateway Retrieve transaction, which is part of HITSP TP13. The XCA Profile is an addendum to the complete IHE IT Technical Infrastructure Technical Framework (ITI-TF). The location of these documents, as well as other foundational standards for this transaction, is listed in Section 1.4 “Referenced Documents and Standards”.

A WSDL for the Responding Gateway actor and a full XML Schema can be accessed via a URL provided in Appendix B of this document.

2.5 Technical Pre-conditions

The following technical pre-conditions exist for this interface specification:

- The initiating NHIO has previously obtained the Document ID and associated metadata needed to retrieve a document; typically through a prior Query for Documents transaction.
- Target gateway and service end point from which to retrieve docs from is identified
- Target document(s) for retrieval are identified

¹ Note that to maintain compliance with HITSP constraints, the document hash value must be consistent between the document query transaction and the document retrieval transaction. See section 2.6 “Technical Post-conditions” and the NHIN Query for Documents specification for more details.



2.6 Technical Post-conditions

The following technical post-conditions will result after the execution of this interface specification:

- Errors encountered will be handled, as specified in Section 4 “Error Handling”.
- Audit records are created and stored by both the requesting and responding NHIO, as described in section 5 “Auditing”.
- Consumer preferences and local policies and permissions were enforced by the responding NHIO.
 - If the requester was not authorized to retrieve a requested document, appropriate errors were returned.
 - For documents where access consent directives allow the retrieval by the requester, the documents were successfully retrieved by the initiating NHIO.
- At its discretion, the initiating NHIO may validate retrieved documents. Validation may occur in the initiating NHIO’s gateway, or by the document consumer in the initiating NHIO upon receiving the document. The initiating NHIO is responsible for any validation performed; handling of errors in validation is dependent on the specific implementation of that NHIO. Validation may be any or all of the following:
 - Validate the document content against the schema dictated by the document type to ensure it is a compliant format
 - Validate the size of the document content against the metadata returned in the prior Query for Documents response. Note that size returned in query response may be -1 if document size is not known at time of query (see NHIN Query for Documents specification for more information).
 - Validate the hash value (SHA1 algorithm) of the document content against the metadata returned in the prior Query for Documents response. Note that hash returned in query response may be -1 if document hash is not known at time of query (see NHIN Query for Documents specification for more information).
 - Validate the mimeType of the document content against the metadata returned in the prior Query for Documents response

Note that validation of the Retrieve Document response transaction’s digital signature is expected to occur within the messaging platform stack, and is not thus included in this list.

3 Interface Definition

3.1 ITI-39 – Cross Gateway Retrieve

This transaction is described in IHE ITI XCA Supplement Section 3.39. The figure below illustrates the actors and transactions involved in the ITI-39 Cross Gateway Retrieve transaction. Note that the diagram represents the Initiating Community (NHIO in this context) as an IHE XDS-based community. The NHIN Retrieve Documents transaction does not require the XDS architecture; it is merely presented in the diagram for illustrative purposes. Sample messages are provided in Appendix A.

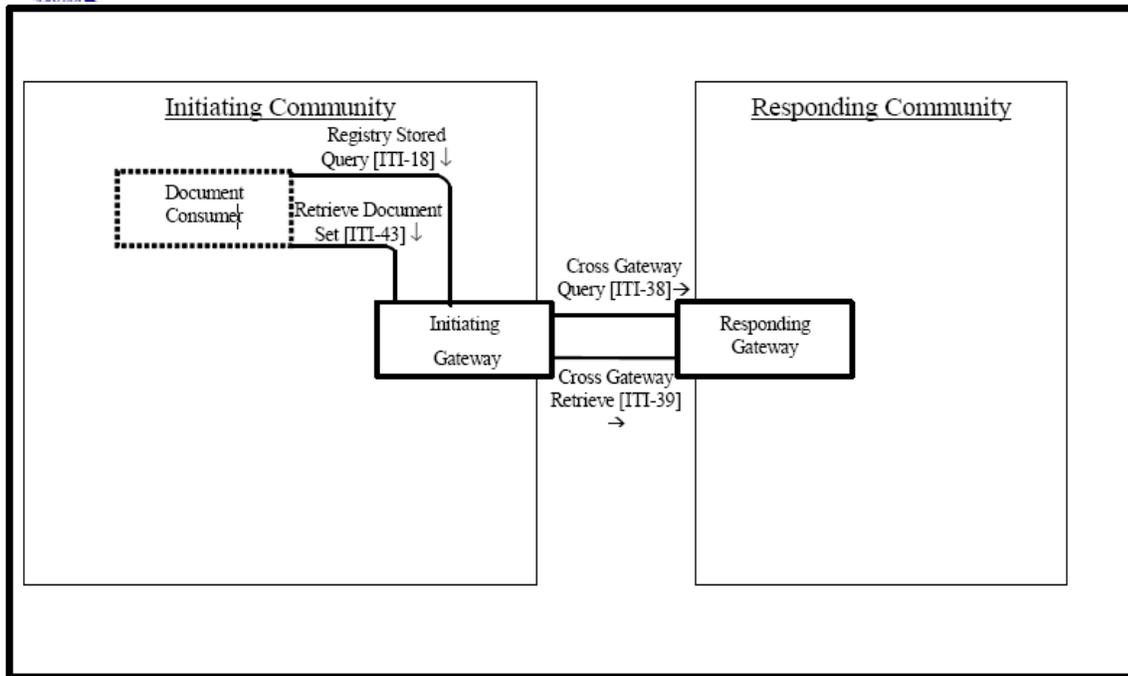


Figure 18.1-1. XCA Actor Diagram

The scope of the Cross Gateway Retrieve transaction is based on the Retrieve Document Set transaction [ITI-43]. Much of the Retrieve Document Set transaction is inherited by the Cross Gateway Retrieve transaction.

Responding NHIN Gateways shall support asynchronous retrieve requests as described in the XCA Supplement section 3.39 and 3.39.5 (Note Section 3.39.5 is significantly updated by approved IHE Change Proposal 420 and is adopted for use by NHIN, see Section 1.4 for reference to this change). Initiating NHIN Gateways may choose whether to use synchronous or asynchronous interactions..

Through the Query for Documents transaction, an NHIO will receive one or more Document ID references (or pointers) to documents for patient records that satisfied given query parameters for a given patient. This transaction will allow the requester to use that reference to request a patient record document; and allow the responder to securely return the document to the requestor and audit the retrieval of the document.

Detailed interaction diagrams are found in the IHE XCA Integration Profile.

3.1.1 homeCommunityId

A community (referred to as an NHIO in this context) is identifiable by a globally unique id called the homeCommunityId. Membership of a facility/enterprise in one community does not preclude it from being a member in another community. An NHIO may be an XDS Affinity Domain that defines document sharing using the XDS profile or another type of community with a different internal sharing structure

The following information is included in the IHE XCA profile to define the use of the homeCommunityId. Annotations (not from IHE) related to the NHIN are included in square brackets:

- The homeCommunityId is a globally unique identifier for a community used to assist in requests for locating the data held by that community. homeCommunityId is structured as an OID limited to 64 characters and specified in URI syntax, for example the homeCommunityId of 2.16.840.1.113883.3.166 would be formatted as urn:oid: 2.16.840.1.113883.3.166.



- Each NHIO shall use the homeCommunityId of the form “urn:oid:n.n.n.n” (using a globally unique OID assigned to the NHIO) when responding to a Cross Gateway Query. The Initiating Gateway is expected to use this homeCommunityId to correlate a subsequent Retrieve Document request to the NHIO that holds the requested data.
- It is returned within the response to Cross Gateway Query and Registry Stored Query transactions to indicate the association of a response element with a community. It is specified as the ebRIM home attribute within the relevant response elements. Document Consumers process the value in the response as an opaque unique identifier.
- It is an optional parameter to Registry Stored Query requests, not requiring a patient id parameter, and Retrieve Document Set requests to indicate which community to direct the request. [This use does not apply to the findDocuments query, which is the only form of Query Registry supported by the NHIN]
- It is used by Initiating Gateways [when retrieving documents] to direct requests to the community where the initial data originated.

3.1.2 Document Persistence

NHIOs that generate documents “on demand” by aggregating data from multiple sources must ensure that the generated document remains available (unaltered) once a document has been retrieved once.

Specifically:

1. A document reference may “expire” within some time period (defined by the NHIO) after a Query for Documents request has been received and responded to **if and only if** no subsequent Retrieve Documents request has been received and responded to for that document
2. For documents that have been shared with another NHIO via a Retrieve Documents request, the document reference and the document itself must remain available for future Retrieve Documents requests.

3.2 Retrieve Documents Transaction

The Retrieve Documents transaction can be described in the following three steps. Each step is described in detail in the XCA Supplement section 18.3.3.

3.2.1 Document Consumer

Document Consumer initiates a Retrieve Document Set – in cases where the initiating side of the Retrieve Documents transaction is not an XDS Affinity domain, the initiation of the transaction is through some internal and functionally equivalent manner.

3.2.2 Initiating Gateway

Initiating Gateway processes Retrieve Document Set by initiating Cross Gateway Retrieve to the appropriate Responding Gateway's.

3.2.3 Responding Gateway

Responding Gateway processes Cross Gateway Retrieve – The Responding Gateway within an XDS Affinity Domain processes the Cross Gateway Retrieve by grouping as a Document Consumer and initiating a Retrieve Document Set transaction to the Document Repository identified by the repository unique ID within the request. If the Cross Gateway Retrieve requests multiple documents with different repository unique IDs, the Responding Gateway shall contact multiple Document Repositories and consolidate the responses.

A Responding Gateway may implement architecture other than the XDS Affinity Domain. In this case, it will respond to the Cross Gateway Retrieve in a functionally equivalent manner to that described in the



preceding paragraph: by acquiring the requested data (and formatting into a document if required), and consolidating the requested documents into a single response.

The scope of the Cross Gateway Retrieve transaction is semantically the same as the Retrieve Document Set transaction [ITI-43]. Differences from the Retrieve Document Set transactions are described in the XCA Supplement section 3.39.1.

The XCA specification does not contain a mechanism for the Initiating Gateway to return partial results to the Document Consumer while it waits for additional results from other Responding Gateways. Likewise, the specification does not allow for the Responding Gateway to return a partial result to the Initiating Gateway while it retrieves additional documents from other Document Repositories in its Community. In both cases, only one response is allowed, and the Responding/Initiating Gateway must manage the latency implications of waiting for responses to consolidate. This specification recommends using the XDS error code "XDSRepositoryBusy" to indicate a document that could not be retrieved within the timeout period used by the Responding/Initiating Gateway. (Note: this is an area that the IHE Technical Infrastructure committee continues to evaluate for potential revisions to the XDS and XCA specifications.)

3.3 Retrieve Parameters

The content metadata semantics for Retrieve Documents are as described by the IHE ITI Technical Framework.

The Cross Gateway Retrieve Request shall carry the following information:

- A required repositoryUniqueId that identifies the repository from which the document is to be retrieved. This value corresponds to XDSDocumentEntry.repositoryUniqueId.
- A required documentUniqueId that identifies the document within the repository. This value corresponds to the XDSDocumentEntry.uniqueId.
- The homeCommunityId element that identifies the community holding the document. The homeCommunityId element must be specified in the Cross Gateway Retrieve request .
- The repositoryUniqueId associated to each document requested can be different therefore allowing a single request to identify multiple repositories.

The Cross Gateway Retrieve Response Message shall carry the following information for each of the returned documents:

- A homeCommunityId. This value shall be the same as the homeCommunityId value in the Cross Gateway Retrieve Request Message.
- A required repositoryUniqueId that identifies the repository from which the document is to be retrieved. This value shall be the same as the value of the repositoryUniqueId in the original Cross Gateway Retrieve Request Message. This value corresponds to XDSDocumentEntry.repositoryUniqueId.
- A required documentUniqueId that identifies the document within the repository. This value shall be the same as the documentUniqueId in the original Cross Gateway Retrieve Request Message. This value corresponds to the XDSDocumentEntry.uniqueId.
- The retrieved document in base64binary encoded format
- The MIME type of the retrieved document
- Errors or warnings in case the document(s) could not be retrieved successfully

4 Error Handling

Error codes used in the Retrieve Documents interface will conform to the error codes listed in IHE TF Volume 3 Section 4.1.13. In particular, the XDSDocumentUniqueIdError may be used to indicate that a



document is no longer available. When receiving this error the Initiating Gateway may choose to initiate a new Query for Documents to get a new list of available documents.

Error Code	Description
XDSRepositoryError	Internal Repository Error.
XDSRepositoryBusy	Too much activity
XDSRepositoryOutOfResources	Resources are low.
XDSUnknownRepositoryId	The repositoryUniqueId value could not be resolved to a valid document repository or the value does not match the repositoryUniqueId of the Document Repository
XSDocumentUniqueIdError	The document associated with the DocumentUniqueId is not available. This could be because the document is not available to the Document Repository, the requestor is not authorized to access that document or the document is no longer available
XDSUnknownCommunity	A value for the homeCommunityId is not recognized
XDSMissingHomeCommunityId	A value for the homeCommunityId is required and has not been specified

5 Auditing

Both the Initiating Gateway and Responding Gateway shall audit the Cross Gateway Retrieve as described in section 3.39.4.1.4.

This below section of the supplement is copied below for reference only. Please consult the current XCA supplement to ensure the latest version is being used.

3.39.4.1.4 Security Considerations

Both the Initiating Gateway and Responding Gateway shall audit the Cross Gateway Retrieve. The audit entries shall be equivalent to the entries required for the Retrieve Document Set.

The Initiating Gateway:

- If receiving a Retrieve Document Set transaction from a Document Consumer, shall audit as if it were a Document Repository. See ITI TF-2b: 3.43.6.
- In addition, shall audit the Cross Gateway Retrieve as if it were a Document Consumer except that for EventTypeCode the Initiating Gateway shall specify EV("ITI-39", "IHE Transactions", and "Cross Gateway Retrieve"). See ITI TF-2b: 3.43.6.
- In addition, if interacting with a local Document Repository, shall audit as if it were a Document Consumer. See ITI TF-2b: 3.43.6. One audit record shall be created for each Document Repository contacted.

The Responding Gateway:

- Shall audit the Cross Gateway Retrieve as if it were a Document Repository except that for EventTypeCode the Responding Gateway shall specify EV("ITI-39", "IHE Transactions", "Cross Gateway Retrieve"). See ITI TF-2b: 3.43.6.
- In addition, if interacting with a local Document Repository, shall audit as if it were a Document Consumer. See ITI TF-2b: 3.43.6. One audit record shall be created for each Document Repository contacted.



Appendix A: Sample Messages

The samples in the following two sections show a typical SOAP request and its relative SOAP response. The sample messages also show the WS-Addressing headers <Action/>, <MessageID/>, <ReplyTo/>...; these WS-Addressing headers are populated according to the W3C WS-Addressing standard. The body of the SOAP message is omitted for brevity; in a real scenario the empty element will be populated with the appropriate metadata.

All of the samples presented in this section are also available online on the IHE FTP site at ftp://ftp.ihe.net/TF_Implementation_Material/ITI/packages/.

Sample Retrieve Document Set SOAP Request:

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"
  xmlns:a="http://www.w3.org/2005/08/addressing">
  <s:Header>
    <a:Action s:mustUnderstand="1">urn:ihe:iti:2007:CrossGatewayRetrieve</a:Action>
    <a:MessageID>urn:uuid:0fbfdced-6c01-4d09-a110-2201afedaa02</a:MessageID>
    <a:ReplyTo>
      <a:Address>http://www.w3.org/2005/08/addressing/anonymous</a:Address>
    </a:ReplyTo>
    <a:To s:mustUnderstand="1"
      >http://localhost:2647/XcaService/IHEXCAGateway.svc</a:To>
  </s:Header>
  <s:Body>
    <RetrieveDocumentSetRequest xmlns="urn:ihe:iti:xds-b:2007">
      <DocumentRequest>
        <homeCommunityId>urn:oid:1.2.3.4</homeCommunityId>
        <RepositoryUniqueId>1.3.6.1.4...1000</RepositoryUniqueId>
        <DocumentUniqueId>1.3.6.1.4...2300</DocumentUniqueId>
      </DocumentRequest>
      <DocumentRequest>
        <homeCommunityId>urn:oid:1.2.3.4</homeCommunityId>
        <RepositoryUniqueId>1.3.6.1.4...1000</RepositoryUniqueId>
        <DocumentUniqueId>1.3.6.1.4...2301</DocumentUniqueId>
      </DocumentRequest>
    </RetrieveDocumentSetRequest>
  </s:Body>
</s:Envelope>
```

Sample Retrieve Document Set SOAP Response:

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"
  xmlns:a="http://www.w3.org/2005/08/addressing">
  <s:Header>
    <a:Action s:mustUnderstand="1">urn:ihe:iti:2007:CrossGatewayRetrieveResponse</a:Action>
    <a:RelatesTo>urn:uuid:0fbfdced-6c01-4d09-a110-2201afedaa02</a:RelatesTo>
  </s:Header>
  <s:Body>
    <RetrieveDocumentSetResponse xmlns="urn:ihe:iti:xds-b:2007"
      xmlns:lcm="urn:oasis:names:tc:ebxml-regrep:xsd:lcm:3.0"
      xmlns:query="urn:oasis:names:tc:ebxml-regrep:xsd:query:3.0"
      xmlns:rims="urn:oasis:names:tc:ebxml-regrep:xsd:rims:3.0"
      xmlns:rs="urn:oasis:names:tc:ebxml-regrep:xsd:rs:3.0">
      <rs:RegistryResponse
        status="urn:oasis:names:tc:ebxml-regrep:ResponseStatusType:Success"/>
      <DocumentResponse>
        <homeCommunityId>urn:oid:1.2.3.4</homeCommunityId>
        <RepositoryUniqueId>1.3.6.1.4...1000</RepositoryUniqueId>
        <DocumentUniqueId>1.3.6.1.4...2300</DocumentUniqueId>
        <mimeType>text/xml</mimeType>
        <Document>UjBsR09EbGhjZ0dTQUxNQUFBUUNBRU1tQ1p0dU1GUxhEUzhi</Document>
      </DocumentResponse>
    </RetrieveDocumentSetResponse>
  </s:Body>
</s:Envelope>
```



NHIN Retrieve Documents Web Service Interface Specification v2.0

```
<DocumentResponse>
  <homeCommunityId>urn:oid:1.2.3.4</homeCommunityId>
  <RepositoryUniqueId>1.3.6.1.4...1000</RepositoryUniqueId>
  <DocumentUniqueId>1.3.6.1.4...2300</DocumentUniqueId>
  <mimeType>text/xml</mimeType>
  <Document>UjBsR09EbGhjZ0dTQUxNQUFBUUNBRU1tQ1p0dU1GUXhEUzhi</Document>
</DocumentResponse>
</RetrieveDocumentSetResponse>
</s:Body>
</s:Envelope>
```



Appendix B: WSDL

IHE provides example WSDL definitions for the Responding Gateway actor supporting the Cross Gateway Retrieve Transaction. The WSDL, as well as schema and examples, can be accessed at ftp://ftp.ihe.net/TF_Implementation_Material/ITI/packages/XCA.Support.Materials.v5.zip

Note: this version of the materials includes changes resulting from IHE Change Proposal 420 which is adopted by this specification.