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OMG hData RESTful Transport

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This OMG document replaces the submission document (health/2011-09-04, alpha). It is an OMG Adopted Beta specification and is currently in the finalization phase. Comments on the content of this document are welcome, and should be directed to issues@omg.org by May 21, 2012.

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Preface

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Typographical Conventions

The type styles shown below are used in this document to distinguish programming statements from ordinary English. However, these conventions are not used in tables or section headings where no distinction is necessary.

Times/Times New Roman - 10 pt.: Standard body text

Helvetica/Arial - 10 pt. Bold: OMG Interface Definition Language (OMG IDL) and syntax elements.

`Courier - 10 pt. Bold:` Programming language elements.

Helvetica/Arial - 10 pt: Exceptions

Note – Terms that appear in *italics* are defined in the glossary. Italic text also represents the name of a document, specification, or other publication.

1 Scope

The hData RESTful application programming interface (API) specification defines remote operations for accessing components of a Health Record and sending messages to an EHR system. “RESTful” refers to a style of web services in which resources are identified by URLs and clients uses stateless HTTP operations to perform operations on those resources [14].A related specification, the HL7 hData Record Format (HRF) [1], describes the logical organization of the information in an electronic health record (EHR). Please refer to the HRF specification for more details on the HRF and how it fits into the HL7 version 3 standards.

As described in more detail in section 9 of this specification, the hData specification is a platform specific module (PSM) for the OMG Retrieve, Locate, Update Service (RLUS) platform independent model (PIM). It implements the RLUS PIM Management and Query Interface using a RESTful architectural style.

2 Namespaces

This document uses the following namespaces, which are originally defined in the HL7 HRF specification [1]. This specification uses a number of namespace prefixes throughout, as listed in Table 1. Note that the choice of namespace prefix is arbitrary and not semantically significant.

Namespace Prefix	Namespace URI	Description
hrf	http://www.hl7.org/schema/hdata/2009/06/core	Namespace for elements in this document
hrf-md	http://www.hl7.org/schema/hdata/2009/11/meta	SectionDocument metadata

3 Glossary (non-normative)

HL7 hData Record Format (HRF) – a related specification that specifies an abstract hierarchical organization, packaging, and metadata for individual documents (referred to as “Section Documents” within the HRF specification). Section Documents can be of any type, either XML documents (such as CDA documents, H7v3 messages, or simplified XML wire formats, etc.) or of other media types (such as e.g. MS Word documents or DICOM files). Also contained in this specification is the format for specifying the content that goes into an hData record, which is called the hData Content Profile (HCP) format.

hData Record (HDR) - an single instantiation of the HRF.

OMG hData Restful Transport – the current specification, defining how the abstract hierarchical organization defined within the HRF specification is access and modified through a RESTful approach, using HTTP as the access protocol. It creates a unique mapping to an URL structure, and defines how HTTP verbs such as GET, PUT, DELETE, etc. affect the underlying information.

hData Content Profile (HCP) - a profile of the content of an HDR. The HRF specification contains the definition of the HCP format.

RLUS – a Retrieve, Location, and Update Service, as defined jointly by OMG and HL7.

Semantic Signifier - a structure definition (such as a schema) and an associated set of validation instructions. The semantic signifier describes the structural and semantic definition of the logical records managed by RLUS. The UML diagram below indicates how e.g. XML or DICOM media types relate to the concept of a semantic signifier.

4 Notational Conventions

The keywords "MUST," "MUST NOT," "REQUIRED," "SHALL," "SHALL NOT," "SHOULD," "SHOULD NOT," "RECOMMENDED," "MAY," and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

5 Additional Information

5.1 Acknowledgements

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6 hData Record RESTful Transport

6.1 Overview

Any instantiation of an HRF – called an hData Record (HDR) – can be represented as a set of Hypertext Transfer Protocol (HTTP 1.1, see [8]) resources in a canonical way by mapping the hierarchical structure of the HDR to a URL resource hierarchy underneath the *baseURL* (see below). Each HDR Section and Section Document is represented by a unique URL, which is constructed from the Section paths and Section Document names. The entire HDR is referenced by a base URL that depends on the implementation. See IETF RFC 3986, section 5 for more details. This base URL will be denoted as *baseURL* throughout this document.

6.1.1 Out of Scope

While this specification does not dictate the format of the *baseURL*, the *baseURL* MUST NOT contain a query component. All content within an HDR that uses this transport specification MUST be expressible as a HTTP resource. In the following, the minimum version for HTTP is 1.1.

This specification does not address data modeling in any form. hData is designed to be able to transport clinical data of any Internet Media Type. The HL7 HRF specification describes how established and emerging data models can be used through the hData Content Profile mechanism by hData-enabled systems.

It should be noted that this specification was designed with extensibility in mind, e.g. by not defining certain HTTP methods on classes of HTTP resources. When implementers use these extension points, the interoperability assertion of this specification does not extend to such extensions, but only covers those parts of an implementation that are in conformance with this documents. At the same time, implementers MUST implement all mandatory elements of this specification.

6.1.2 General Conventions

Any HTTP GET, PUT, POST, DELETE, or OPTIONS operation (see [8], section 9) on a given resource that are not implemented MUST return an HTTP response with a status code of 405 that includes an Allow header that specifies the allowed methods. All operations SHOULD return HTTP status codes in the 5xx range if there is a server problem. Other HTTP status code MAY be added by security mechanisms or other extensions.

It is RECOMMENDED that all section document responses include a “Last-Modified” header. It is RECOMMENDED that all document resources support the “If-ModifiedSince” and “If-Unmodified-Since” headers to support conditional GET and optimistic concurrency.

For improved performance it is RECOMMENDED that the server support client requests for GZIP compression. Clients will request compression by setting the Accept-Encoding HTTP header to “gzip.” The server SHOULD honor this request for all documents, so that devices may benefit from the reduced bandwidth needs and improved battery life when requesting compressed content.

6.2 Operations on the Base URL

6.2.1 GET

If there is no HDR at the base URL, the server SHOULD return a 404 - Not found status code.

The server MUST offer an Atom 1.0 compliant feed of all child sections specified in the HRF specification [1], as identified in the corresponding sections node in the root document.

It is RECOMMENDED that the server also offers a web user interface that allows users to access and manipulate the content of the HDR, as permitted by the policies of the system. Selecting between the Atom feed and the user interface can be achieved using standard content negotiation (HTTP Accept header). This is not necessary for systems that are used by non-person entities only. If the Accept header is non-existent, or set to */* or application/atom+xml, the system MUST return the Atom feed. For all other cases the format of the returned resource is left to the implementer.

Status Code: 200, 404

6.2.2 POST – Parameters:extensionID, path, name

This operation is used to create a new Section at the root of the document. The request body is of type "application/x-www-form-urlencoded" and MUST contain the extensionId, path, and name parameters. The extensionId parameter MAY be a string that is equal to value of one of the registered <extension> nodes of the root document of the HDR identified by *baseURL*. The path MUST be a string that can be used as a URL path segment. If any parameters are incorrect or not existent, the server MUST return a status code of 400.

The system MUST confirm that there is no other section registered as a child node that uses the same path name. If there is a collision, the server MUST return a status code of 409.

If the extensionId is not registered as a valid extension, the server MUST verify that it can support this extension. If it cannot support the extension it MUST return a status code of 406. It MAY provide additional entity information. If it can support that extension, it MUST register it with the root.xml of this record.

When creating the section resource, the server MUST update the root document: in the node of the parent section a new child node must be inserted. If successful, the server MUST return a 201 status code and SHOULD include the location of the new section. The name parameter MUST be used as the user-friendly name for the new section.

Status Code: 201, 400, 406, 409

6.2.3 PUT

This operation is undefined by this specification.

Status Code: 405, unless an implementer defines this operation.

6.2.4 DELETE

This operation is undefined by this specification.

Status Code: 405, unless an implementer defines this operation.

6.2.5 OPTIONS

The OPTIONS operation on the *baseURL* is per [8], section 9.2, intended to return communications options to the clients. Within the context of this specification, OPTIONS is used to indicate which security mechanisms are available for a given *baseURL* and a list of hData content profiles supported by this implementation. All implementations MUST support OPTIONS on the *baseURL* of each HDR and return a status code of 200, along with:

- The X-hdata-security HTTP header defined in section of this specification. The security mechanisms defined at the *baseURL* are applicable to all child resources, i.e., to the entire HDR.

- An X-hdata-hcp HTTP header that contains a space separated list of the identifiers of the hData Content Profiles supported by this implementation.
- The X-hdata-extensions HTTP header contains a space separated list of the identifiers of the hData extensions supported by this implementation independent of their presence in the root document at *baseURL*/root.xml (cf. section XXX in [1] describing the root document format for an explanation of the extensions in a root.xml).

The server MAY include additional HTTP headers. The response SHOULD NOT include an HTTP body. The client MUST NOT use the Max-Forward header when requesting the security mechanisms for a given HDR.

Status Code: 200

6.3 *baseURL*/root.xml

6.3.1 GET

This operation returns an XML representation of the current root document, as defined by the HRF specification.

Status Code: 200

6.3.2 POST, PUT, DELETE

These operations MUST NOT be implemented.

Status Code: 405

6.4 *baseURL/sectionpath*

6.4.1 GET

This operation MUST return an Atom 1.0 [3] compliant feed of all section documents and child sections contained in this section. Each entry MUST contain a link to a resource that uniquely identifies the section document or child section. If the section document type defines a creation time, is RECOMMENDED to set the Created node to that datetime.

For section documents, the Atom Content element MUST contain the XML representation of its metadata (see [1], Section 2.4.1).

Status Code: 200

6.4.2 POST

For creating a new sub section, three additional parameters are used, and the POST will create a new child section within this section. For new documents a document MUST be sent that conforms to the business rules expressed by the extension that the section has registered.

6.4.2.1 Add new section – Parameters: extensionId, path, name

The content type MUST equal “application/x-www-form-urlencoded” for the POST method to create a new sub section. The extensionId parameter is the URI in the root.xml document that identifies the Extension element. If the extensionId is not registered as a valid extension, the server MUST verify that it can support this extension. If it cannot support the extension it MUST return a status code of 406 and MAY provide additional information in the entity body. If it can support that extension, it MUST register it with the root.xml of this record. The path MUST be a string that can be used as a URL path segment. The name parameter MUST be used as the user-friendly name for the new section. If any parameters are incorrect, the server MUST return a status code of 400.

The system MUST confirm that there is no other section registered as a child node that uses the same path name and that it can create a new subsection identified by the path parameter. If there is a collision, the server MUST return a status code of 409.

When creating the section resource, the server MUST update the root document: in the node of the parent section a new child node must be inserted. The server MUST return a 201 status code. The extensionId and path parameters are REQUIRED, the name parameter is OPTIONAL.

Status Code: 201, 400, 406, 409

6.4.2.2 Add new document

When adding a new section document, the request Content Type MUST be “multipart/form-data” if including metadata. In this case, the content part MUST contain the section document. The content part MUST include a Content-Disposition header with a disposition of “form-data” and a name of “content.” The metadata part MUST contain the metadata for this section document. The metadata part MUST include a Content-Disposition header with a disposition of “form-data” and a name of “metadata.” It is to be treated as informational, since the service MUST compute the valid new metadata based on the requirements found in the HRF specification. The content media type MUST conform to the media type of either the section or the media type identified by metadata of the section document. For XML media types, the document MUST also conform to the XML schema identified by the extensionId for the section or the document metadata. If the content cannot be validated against the media type and the XML schema identified by the content type of this section, the server MUST return a status code of 400.

If the request is successful, the new section document MUST show up in the document feed for the section. The server returns a 201 with a Location header containing the URI of the new document.

Status Code: 201, 400

6.4.3 PUT

This operation is not defined by this specification.

Status Code: 405, unless an implementer defines this operation.

6.4.4 DELETE

This operation MAY be implemented, but special precaution should be taken: if a DELETE is sent to the section URL, the **entire** section, its documents, and subsections are completely deleted. Future requests to the section URL MUST return a status code of 404, unless the record is restored. If successful the server MUST return a status code of 204. If DELETE is implemented, special precautions should be taken to assure against accidental or malicious deletion. Future requests to the section URL MAY return a status code of 410, unless the record is restored.

Status Code: 204, 404, 410

6.5 *baseURL/sectionpath/documentname*

6.5.1 GET

This operation returns a representation of the document that is identified by *documentname* within the section identified by *sectionpath*. The *documentname* is typically assigned by the underlying system and is not guaranteed to be identical across two different systems. Implementations MAY use identifiers contained within the infoset of the document as *documentnames*.

If no document of name *documentname* exists, the implementation MUST return a HTTP status code 404.

Status Codes: 200, 404

6.5.2 PUT

This operation is used to update a document by replacing it. The PUT operation MUST NOT be used to create a new document; new documents MUST be created by POSTing to the section. If the client attempts to create a new document this way, the server MUST return a 404. The content MUST conform to the media type identified by the document metadata or the section content type. For media type application/xml, the document MUST also conform to the XML schema that corresponds to the content type identified by the document metadata or the section. If the parameter is incorrect or the content cannot be validated against the correct media type or the XML schema identified by the content type of this section, the server MUST return a status code of 400.

If the request is successful, the new section document MUST show up in the document feed for the section. The server returns a 200.

Status Code: 200, 400, 404

6.5.3 POST

This operation is used to replace metadata on a section document. When replacing the metadata, the hrf-md:DocumentId MUST NOT be changed – the server MUST return a status code 403 if this is attempted. This operation SHOULD NOT be used unless necessary for replicating information within an organization. If a section document is copied from one system to another, a new document metadata instance MUST be constructed from the original metadata according to the rules in the HRF specification.

The request Media Type MUST be application/xml. The body MUST contain the document metadata. It MUST conform to the XML schema for the document metadata, defined in [1]. If the metadata is not of media type application/xml or it cannot be validated against the document metadata XML schema, the server MUST return a status code of 400.

If the request is successful, the document metadata for the section document MUST be updated. The server returns a 201.

Status Code: 201, 400, 403

6.5.4 DELETE

This operation MAY be implemented. If a DELETE is sent to the document URL, the document is completely deleted. If DELETE is implemented, special precautions should be taken to assure against accidental or malicious deletion. Future requests to the section URL MAY return a status code of 410, unless the record is restored.

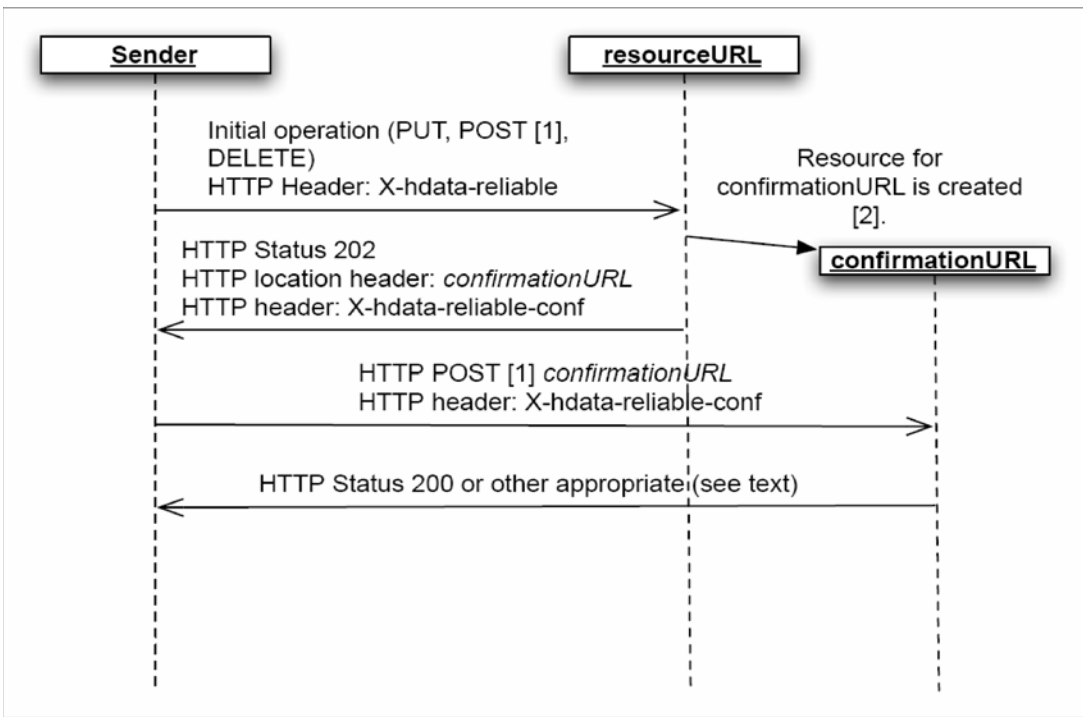
Status Code: 204, 410

7 Complex Operations

7.1 Reliable Operation Pattern

This pattern is a complex multi-step exchange, applicable to situations where reliable transfer of information is required. This pattern MAY be combined when interacting with an hData Record or with other message patterns, as long as there is no overloading of HTTP methods.

The use of the reliable operations pattern will be governed by the business requirements of the business domain. It should be noted that this pattern breaks the statelessness of the service. As such, it cannot be used easily with load balancers and similar horizontal scaling techniques.



[1] All POST methods must be implemented to support idempotency, e.g. through mechanisms like "Post Once Exactly" (POE).

[2] The confirmationURL may be identical to the resourceURL for document transactions.

Please see the text for more details on the interactions.

The flow of the patterns is as follows:

1. The sender accesses the *resourceURL* resource using PUT, POST, or DELETE. To indicate that it wants to use the reliable operations pattern, it sets the HTTP message header “X-hdata-reliable.”

2. If the *resourceURL* is capable of performing the reliable operations pattern, it will create a new resource for a message at *confirmationURL*, and return an HTTP status code of 202. The HTTP result MUST contain the *confirmationURL* in the HTTP location header and a confirmation secret in the “X-hdata-reliable-conf” header. This secret SHOULD be a simple string of sufficient length to prevent guessing. The service MUST NOT process the message at this stage. This means that once the *confirmationURL* is created the resource is locked, until the pattern completes, or after a preconfigured time-out. The server MUST send a HTTP status code 405 to any client trying to modify that resource while the resource is locked.
   If the *resourceURL* does not implement the reliable operations pattern, it MUST return an HTTP status code of 405 and discard the message.

3. The sender MUST then POST an empty request body to the resource at *confirmationURL* and set the “X-hdata-reliable-conf” header to the value provided in step 2. Upon receipt, the service – listening at the *confirmationURL* – MUST validate the confirmation secret. Once the GET secret is validated, the service processor MUST process the message immediately.

4. If the validation is successful, the *confirmationURL* returns an HTTP result with the expected status code for the initial operation. If the validation is not successful, the service MUST return an HTTP status code of 409. The sender MUST retry the POST until it receives either a different HTTP status code.

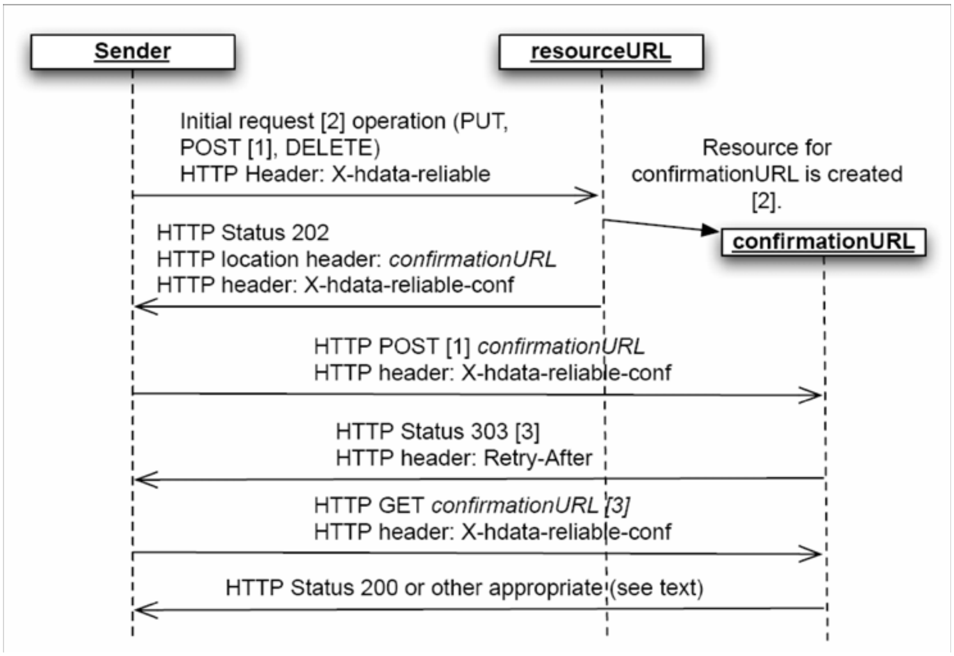
Remarks:

1. Since POST is not idempotent, the service MUST implement a safe guard against duplicity of requests for all POSTs in this flow. It is RECOMMENDED that the service implements “POST Once Exactly” (POE) [13].

2. The *confirmationURL* resource MAY be destroyed after the reliable message pattern flow is complete. The service MAY maintain the *confirmationURL* after the pattern flow completes.

3. If the initial operation in step 1 above is an application-level request message or document, the *confirmationURL* MAY provide an application-level response in step 4. The response MAY be provided by returning the response body in the final step; the HTTP status code MUST NOT be 409. For asynchronous responses, the *confirmationURL* MAY return an HTTP status 303 with a “Retry-After” header, indicating when the response will be available through a GET operation at the *confirmationURL*.

7.2 Asynchronous Request/Response Pattern



This pattern extends the Reliable Operations Pattern to enable a simple asynchronous request response pattern. It allows a service to direct a client to return at a later time and pickup the result of a given request, by using the HTTP Retry-After header.

[1] All POST methods must be implemented to support idempotency, e.g. through mechanisms like "Post Once Exactly" (POE).

[2] The request/response protocol is defined at the application level and not through this specification. The Sender and the service at the resourceURL will determine if the operation is a request.

[3] The 303/Retry-After step is optional. It MAY be used for asynchronous responses.

Please see the text for more details on the interactions.

This specification does not provide guidance to what constitutes an application-level request/response protocol. Implementers of this specification can decide if this mechanism is appropriate for their application.

1. There is no default for how long the *confirmationURL* resource i*s available for* confirmation (step 3). The service MAY destroy the *confirmationURL* resource and discard the message if the sender does not complete step 3 of the pattern flow. It is strongly RECOMMENDED to advertise the maximum time for confirming the message to the developer of the sender in the documentation for the service. If the service discards the message after timing out *the confirmati*on step, it MUST return a status code of 404 at the *confirmationURL* permanently. If the service issued a "Retry-After" header in response (as indicated in Remark 3.), it MUST provide the *confirmationURL* until after the expiration of the time indicated by this header.

2. For operations on hData Records (as described in section 6) special provision MUST be taken to prevent alteration of the resource once the reliable message pattern is initiated. This means that once the *confirmationURL* is created the resource is locked, until the pattern completes, or after a preconfigured time-out. The server MUST send a HTTP status code 405 to any client trying to modify that resource while the resource is locked. The service MUST provide the old status of the resource until step 3 completes. It is RECOMMENDED to use the resource URL (which is different from the URL for the metadata for the resource URL) also as the *confirmationURL*.

8 Security Considerations

This transport and API specification can be used to transfer data in many different situations, for example, inside organizations, between organizations, or from medical devices. As such, the specification cannot provide a comprehensive security solution that addresses the needs of all possible applications. However, this section describes a number of basic security mechanisms that hData implementations MUST support. In addition, this section describes general web security considerations and how additional security mechanisms and systems can be added to implementations of this standard. Implementers of hData are advised to review their domain specific security requirements and select or create appropriate security mechanisms. The section concludes with a discussion of risk analysis, which is highly recommended prior to implementing and deploying any infrastructure for clinical systems.

While this specification does not define any access controls to the web resources, it is RECOMMENDED that a comprehensive access control management system is always deployed with any hData installation.

8.1 Security Mechanism Specification

To allow the support of multiple security mechanisms at a single HRF resource, clients MUST be able to always access the *baseURL* through an HTTP OPTIONS request (see [8], section 9.2). If the resource employs any security mechanism with the exception of transport security (see 8.2.1), it MUST include the HTTP header X-hdata-security that MUST contain a space separated list of URL-encoded URIs that identify the supported security mechanism. Section 8.2 includes the URIs for the baseline security mechanisms.

It is RECOMMENDED that hData Content Profiles include a detailed specification of any required custom security mechanisms. If the custom security mechanism The URIs for identifying these additional security mechanisms SHOULD be made unique by using the DNS domain name in the first part of the URI.

Any new security mechanism specification that is compliant with this standard needs to provide the following items. This SHOULD be done through a commonly readable text document, such as HTML. This package provides implementers with the necessary security protocol information to create the security mechanism for their system.

1. Common Name (REQUIRED) – free text, recommended to be less that 32 characters.
2. Identifier (REQUIRED) – URI, recommended to include the originating organizations DNS domain name for uniqueness. NOT REQUIRED for transport security (see 4.2.1). It is RECOMMENDED to use a URL that resolves into the HTML representation of the security mechanism specification.
3. Exclusiveness (REQUIRED) – free text, describes if the mechanism can be combined with other mechanism.
4. Description (REQUIRED) – free text, includes a comprehensive description of all allowed interaction patterns, parameters, and dependencies.
5. State diagram (RECOMMENDED) – UML state diagram, identifies all actors and illustrates all allowed interaction patterns.
6. Business rules (RECOMMENDED) – free text, describes the business/domain justification and rules for this security mechanism.
7. Example (RECOMMENDED) – free text, recommended to include examples including packet content for all interaction patterns.
8. Other Content (OPTIONAL)

8.2 Baseline Security

The mechanisms described in this section MUST be supported by all implementation of this specification. While transport security is always RECOMMENDED, there can be situations where transport security is not required.

The versions of IETF standards selected within this specification are the minimal REQUIRED versions. It is RECOMMENDED to use more modern versions, as long as these newer versions are backward compatible.

8.2.1 HTTP Transport Security

Transport security is implemented within the network stack below the HTTP transport layer.

1. Common Name: HTTP Transport Security
2. Identifier: none – Not required because the identifier is encoded in the *baseURL* URL through the https scheme.
3. Exclusiveness: This mechanism can be combined with all other security mechanism.
4. Description: Implementations MUST support TLS 1.1 or higher. This protocol is described in detail in IETF RFC 4345 [2]. TLS supports both anonymous clients, as well as client authentication. Implementations of this specification MUST support anonymous client, and MUST support client authentication through TLS. If TLS client authentication is supported, implementation MAY use the principal obtained from the exchange in their authentication and authorization process.

8.2.2 Message Security

1. Common Name: S/MIME Message security
2. Identifier: http://www.omg.org/hdata/2011/03/security/smime-messages
3. Exclusiveness: This mechanism can be combined with all other security mechanisms.
4. Description: Implementations MUST support S/MIME 3.2 or higher which is an IETF internet standard described in IETF RFC 5751 [4]. S/MIME requires PKI certificates for sender and receiver, and also a way for the sender to discover the public key certificate for the receiver. The sender should include its own certificate in the S/MIME message. Implementations MUST use SHA-256 and RSA for signature and encryption, respectively. To achieve confidentiality, implementations MUST use the EnvelopedData content type [10], section 2.4.3. The hData SectionDocument that becomes the MIME payload of the S/MIME message MUST be prepared by the implementation according to the requirements of the S/MIME specifications, with special consideration for the MIME content type.

   While out of scope for this specification, there are a number of ways to discover the certificates:

   - If the receiver offers any web resources through https, it is RECOMMENDED to use the server certificate.
   - If any discovery services are available, it is RECOMMENDED that the metadata for the endpoint includes the public key certificate.
   - If DNS CERT resource records (IETF 4398 [5]) are available, the sender MAY use the certificate published.

8.2.3 Authentication

Authentication can be achieved through all of the mechanisms described in this section. Implementations of this specification MUST support all described authentication mechanisms, but these mechanisms MAY be disabled at deploy or runtime.

8.2.3.1 HTTP Basic Authentication

1. Common Name: HTTP Basic Authentication
2. Identifier: http://www.omg.org/hdata/2011/03/security/http-basic-auth
3. Exclusiveness: This mechanism can be combined with all other security mechanisms. When combining with other authentication mechanisms, it SHOULD use the other mechanism's security principal for authentication and authorization.
4. Description: Implementations MUST implement HTTP Basic Authentication as specified in IETF RFC 2617 [6], section 2.

8.2.3.2 HTTP TLS Authentication

1. Common Name: HTTP over TLS
2. Identifier: http://www.omg.org/hdata/2011/03/security/http-tls-auth
3. Exclusiveness: This mechanism SHOULD NOT be combined with other authentication security mechanisms. If combined with other security mechanisms, the principal of the client certificate, as identified by the Common Name (CN) attribute of the certificate, SHOULD be used as the security principal in all subsequent authentication and authorization decisions.
4. Description: Implementations MUST implement HTTP TLS Client Certificates as specified in IETF RFC 2246 [7], section 7.4.6.

8.3 Specifying A Custom Security Mechanism

Additional security mechanisms that can be published through the X-hdata-security header can be created as needed by the behavioral model and the application domain. It is RECOMMENDED to include or reference security mechanisms necessary for a given hData Content Profile (HCP) within the HCP package. The security mechanism description MUST comply with the template specified in Section 8.2, "Baseline Security."

8.4 General Web Security Considerations

Because hData is implemented using common web technology, it is subject to the same security considerations as other security-sensitive web applications and services. Because Internet threats and vulnerabilities are constantly evolving, hData implementations should apply current best practices to assure appropriate levels of security.

These security best practices should be considered not only at the software application layer, but also at lower layers such as the network layer and physical layer. For example, hData implementations MAY also support lower-level protection mechanisms, such as IPSEC or other bulk traffic encryption. Typically, such technologies have no direct impact on the application layer, and their use and implementation is determined by the networking infrastructure. Protection of critical infrastructure services such as DNS or DHCP MAY be necessary. Information security must be integrated with non-IT security as well:

- Any information processing systems must be protected from intentional and unintentional physical harm, both man-made as well as natural.
- Business processes and non-IT workflow must integrate with information security, and prevent circumvention of information security measures.
- System operators and end users must be cleared for access at the appropriate level.

The reader is advised to consult appropriate resources in this area for more information, such as NIST 800-12, NIST 800-14, ISA-99, and ISO 27002.

8.5 Risk Assessment Approach and Best Practices

It is highly RECOMMENDED to perform a comprehensive risk analysis prior to deploying any clinical application. Risk analysis is a systematic consideration of the threats, vulnerabilities, and consequences of gaps in security, as well as mitigation strategies for risks. Often, the threats and vulnerabilities are captured in terms of specific scenarios that can be re-used during security audits throughout the system's lifecycle. The reader is advised to consult appropriate resources for more information on cyber risk assessment, such as NIST 800-30, the IHE security cookbook [11], and ISO/TS 25238.

9 Realization of RLUS Profiles

9.1 Introduction

The Retrieve, Locate, Update Service (RLUS) Specification defines an HL7 framework for healthcare services. The hData RESTful Transport is a realization of RLUS Functional Profiles. The hData Content Profile (HCP) [1], section 3, acts as such as a Semantic Profile in the sense of [5], section 6.1. Taken together, the two portions of the hData specification forms an RLUS Conformance profile. This section provides a mapping between the hData RESTful implementation and the RLUS framework.

It should be noted that while this section is necessary to establish hData as a Platform Specific Module of the OMG RLUS Platform Independent Module, it does not require any additional implementation burden on the developer.

9.2 Implementation of RLUS Interfaces

The RLUS specification defines a number of interfaces in [9], Section 5.4 “Detailed Functional Model.” These are mostly implemented by the hData specification, as detailed within the table below. Note that a SectionDocument is the hData realization of a RLUS Resource.

Table 9.1 - RLUS Runtime/Management and Query Interface

HL7 RLUS SFM (CIM) – RLUS Basic Runtime Capabilities	OMG RLUS STM PIM Management and Query Interface (version 1.0.1, formal/ 2011-07-02)	hData RESTful Platform Specific Model (PSM) Implementation	Note
Locate Resources (4.4.1)	Locate (7.4)	GET (baseURL) GET (baseURL/sectionpath)	Parameter-specific query may be implemented either over a single HDR or a collection of HDR by another specification. This is out-of-scope for the HRF and this specification.
Get Resource (4.4.2)	Get (7.2)	GET (baseURL/sectionpath/ documentname)	This is implemented using an HTTP GET operation on the resource identified by its URL.
List and Get Resource (4.4.3)	List (7.3)	Not implemented	The Atom 1.0 feed returned at each Section level as well as at the *baseURL* (see Sections 6.4.1 and 6.2.1, respectively) implements the List Interface
Put Resource (4.4.4)	Put (7.5)	POST (baseURL/sectionpath)	Sub clause 6.4.2.2 (Add new document) describes how a new SectionDocument can be created.

Table 9.1 - RLUS Runtime/Management and Query Interface

Initialize Resource (4.4.5)	Initialize (7.8)	Not implemented	The initialization of a resource and the actual creation is always performed in a single transaction within hData. As such, when creating a new SectionDocument as described in Section 6.4.2.2, hData returns the location of the newly created resource as part of the transaction. As such, this operation by itself makes no sense in the hData RESTful context
Discard Resource (4.4.6)	Discard (7.6)	DELETE (baseURL/sectionpath)	Section 6.5.4 (DELETE) describes how a SectionDocument can be deleted.

Section 5.6 in the HL7 RLUS SFM describes the Introspective Capabilities, which are mapped to hData in the following table.

Table 9.2 - RLUS Introspective/Semantic Profiles Interface

HL7 RLUS SFM (CIM) – Introspective Capabilities	OMG RLUS STM PIM Semantic Profiles interface (version 1.0.1, formal/2011-07-02)	hData RESTful Platform Specific Model Implementation	Note
List Conformance Profiles (4.6.1)	List Conformance profiles (13.6)	OPTIONS (baseURL)	Section 6.2.5 (OPTIONS) describes the X-hdata-hcp header which returns a list of hData content profiles.
List Semantic Signifiers (4.6.2)	List Semantic Signifier (13.5)	GET (hDataRoot/root.xml) or OPTIONS (baseURL)	The root.xml at the baseUrl contains the list of supported elements within the Extensions node. The list of Extension elements represents the list of semantic signifiers, as required by [5] 5.2.1. (The HRF specification [1] recommends URLs as identifiers for each Extension, which should resolve into a RDDL document describing the given Extension. This is consistent with the recommendation of [5] section 5.2.1 to provide an explanation for each semantic signifier.) Alternatively, the list of Extension can also be obtained throught the OPTIONS request against the baseURL and the evaluation of the X-hdata-extension HTTP header (see section 6.2.5).

Table 9.2 - RLUS Introspective/Semantic Profiles Interface

Describe Semantic Signifier (4.6.3)	Describe (7.7)[a] Find Semantic Signifier (13.3)	GET (url)	For any <Extension> that is a URL and resolves into a RDDL document, the necessary description can be retrieved. Thus, if an hData implementation strives to be compliant to this interface, recommendation in [1] section 2.3 to use URLs and resolve into RDDLs becomes a requirement.
Put Semantic Signifier (4.6.4)	Create Semantic Signifier (13.2) Update Semantic Signifier (13.4)	Not implemented	hData does not allow explicit creation of new Extensions for a given system. However, if the system supports Extensions that are not currently registered in the root.xml document, they can be added to the record by creating a new Section as described in Section 6.2.2 and 6.4.2.

a. For pragmatic reason Describe operation, currently, is included in the Management and Query Interface of the OMG. PIM

Since the above mapping provides the Basic Runtime and the Introspective Capabilities, hData implements RLUS at Level 2 (see [9], section 6.2).

Annex A - Bibliography

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[10] “Secure/Multipurpose Internet Mail Extensions (S/MIME) Version 3.1 Message Specification,” RFC 3851, The Internet Society, July 2004, online at http://www.rfc-editor.org/rfc/rfc3851.txt

[11] “Cookbook:Preparing the IHE Profile Security Section,” IHE International, October 2008, online at http://www.ihe.net/Technical_Framework/upload/IHE_ITI_Whitepaper_Security_Cookbook_2008-11-10.pdf

Annex B - Non Normative POST Example

The following example illustrates the wire-level representation of an HTTP POST operation adding a new SectionDocument (see also Section 2.4.2.2) using a simplified payload.

```
POST /example.com/additionalPatientInfo/patient1234/allergies/ HTTP/1.0

Content-Length: 1105

Content-Type: multipart/form-data; boundary=END_OF_PART

--END_OF_PART

Content-Disposition: form-data; name="content"

Content-Type: application/xml


<allergy:allergy xmlns:allergy="http://projecthdata.org/hdata/schemas/2009/06/
allergy">

  <allergy:product codeSystem="2.16.840.1.113883.6.88" code="310965" />

  <allergy:narrative>Ibuprofen allergy</allergy:narrative>

</allergy:allergy>

--END_OF_PART

Content-Disposition: form-data; name="metadata"

Content-Type: application/xml


<hrf-md:DocumentMetaData>

  <hrf-md:DocumentId>allergy1.xml</hrf-md:DocumentId>

  <hrf-md:RecordDate>

      <hrf-md:CreatedDateTime>

          2009-10-10T09:21:55Z

      </hrf-md:CreatedDateTime>

      <hrf-md:Modified>

          <hrf-md:ModifiedDateTime>

              2011-08-13T18:30:02Z

          </hrf-md:ModifiedDateTime>
```

```
      </hrf-md:Modified>
   </hrf-md:RecordDate>
   <hrf-md:LinkedDocuments>
      <hrf-md:LinkInfo>
         <hrf-md:Target>
            http://example.com/additionalPatientInfo/patient1234/allergies
         </hrf-md:Target>
      </hrf-md:LinkInfo>
   </hrf-md:LinkedDocuments>
</hrf-md:DocumentMetaData>
--END_OF_PART--
```