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HL7 Version 3 Implementation Guide: Context-Aware Knowledge Retrieval (Infobutton) Service-Oriented Architecture Implementation Guide, Release 1

HL7 Draft Standard for Trial Use

March 2011

Publication of this draft standard for trial use and comment has been approved by Health Level Seven International (HL7). This draft standard is not an accredited American National Standard. The comment period for use of this draft standard shall end 24 months from the date of publication. Suggestions for revision should be submitted at http://www.hl7.org/dstucomments/index.cfm.

Following this 24 month evaluation period, this draft standard, revised as necessary, will be submitted to a normative ballot in preparation for approval by ANSI as an American National Standard. Implementations of this draft standard shall be viable throughout the normative ballot process and for up to six months after publication of the relevant normative standard.

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1 Executive Summary

Clinicians face numerous knowledge needs during the course of patient care and the majority of these needs are not met, compromising the quality of care. Likewise, in order to be partners in the decision making process, patients need to be well-informed about their health and health care options.Online health knowledge resources that are capable of solving clinicians' and patients' knowledge needs are now widely available, but a series of barriers hinder a more effective and frequent use of these resources to support decision-making. Context-aware knowledge retrieval into Clinical Information Systems (CIS), such as Electronic Health Record (EHR) and Personal Health Record (PHR) systems, is an increasingly promising approach for delivering relevant clinical knowledge to the point of care as well as patient-tailored educational material to support patient-centered care. These kinds of knowledge retrieval tools have been known as *Infobuttons*.[1]

To support the integration of knowledge resources into CISs, the Clinical Decision Support Work Group(CDS WG) has been developing a set of standard specifications for context-awareknowledge retrieval. The first of these specifications, entitled *Context-Aware Knowledge Retrieval, Knowledge Request Standard*, was approved in September 2010 as a normative ANSI/ISO HL7 standard.[3] This specification provides a standard mechanism for Clinical Information Systems to submit knowledge requests to knowledge resources.In addition, a URL-based implementation guide was developed to specify knowledge request implementations using the HTTP protocol.[4]

The present specification complements the previous onesby enabling the implementation of context-aware knowledge retrievalapplications through a Service-Oriented Architecture (SOA) based on either the SOAP (*Simple Object Access Protocol*) protocol (Section 3.1) or the REST (*Representational State Transfer*) software architecture style (Section 3.2).

1.1 Scope of this Draft Standard for Trial Use ballot

This specification aims to:

(a) Describe the functional requirements for SOA context-aware knowledge retrieval implementations (Section 2);
(b) Provide guidance regarding SOAcontext-aware knowledge retrieval implementationsbased on the SOAP protocol (Section 3.1);
(c) Provide guidance regarding SOA context-aware knowledge retrieval implementationsbased on the REST software architecture style (Section 3.2);
(d) Specify the knowledge response service payloadfor the two SOA context-aware knowledge retrieval implementation options listed above (Section 3).

2 Functional Requirements

2.1 Scenario– Integration with knowledge resources via Infobutton Manager

The following scenario illustrates the process through which a clinician accesses context-specific knowledge retrieved from multiple resources from within a CIS. A knowledge broker called *Infobutton Manager*[2] mediates the integration between the CIS and the multiple resources as described in the steps below. The resources respond with structured metadata that describe the retrieved knowledge content, a summary of the knowledge content and/or the entire content itself, and links to the complete knowledge content at its source. The structured metadata enable Infobutton Managers to filter, process, and aggregate, retrieved knowledge from multiple resources. It also enables rendering of aggregated content into various user interfaces, depending on application specific requirements. The scenario described below is illustrated in Figure 2.

Dr. Jones is looking at a problem list of a male, 77 year-old patient with Heart Failure. Dr. Jones clicks on an infobutton located next to the Heart Failure problem list entry.

(a) The CIS sends a knowledge request to an Infobutton Manager.
(b) The Infobutton Manager acts as a broker, sending requests for context-specific knowledge to multiple knowledge resources.
(c) Each knowledge resource responds with metadata about the content items that are considered to be relevant based on the CIS context. The knowledge resource response includes the following elements:
    - Knowledge topics (e.g., etiology, treatment, prognosis) that are covered by the resource and that might be relevant given the CIS context;
    - Knowledge metadata (e.g., knowledge author, type of content, last update date);
    - Summary of the retrieved knowledge topics;
    - Complete content represented in one or multiple formats (e.g., HTML, XML, binary) or a pointer to the complete content at its original source.
(d) The Infobutton Manager produces a knowledge response aggregatingthe responsesobtained from the multiple knowledge resources and sends the response back to the CIS.
(e) The CIS renders the knowledge response content and presents it to Dr. Jones for content browsing and navigation. Dr. Jones selects a specific knowledge topic (e.g., diagnosis, therapy) from one particular resource. The resource responds with the complete content, which is then presented to Dr. Jones. Alternatively, if the desired content is not satisfactory then Dr. Jones may return to the aggregate summary select a different topic and/or knowledge resource.

2.2 Scenario –Integration with knowledge resources for personalized patient education handout

The following scenario describes the process in which a healthcare provider creates a personalized patient education handout by selecting pieces of content from one or more resources.The scenario exemplifies a potential rendering approach for the content retrieved and aggregated in the previous scenario and in Figure 2. The scenario is just an illustration of a specific knowledge integration use case and does not entail additional requirements or actors for the standard specification.

Dr. Jones opens up the records of a female, 72 year-old patient with a number of entries on her problem list and medications list. Dr. Jones launches a CIS module called “patient handout builder.”

(a) The patient handout builder receives a request from the CISto retrieve relevant patient education content to help Dr. Jones build a customized/personalized patient education handout. The CISsends the patient’s entire problem list and medications list as part of the request.

- Alternatively, Dr. Jones selects a subset of problem and medication list items that should be included in the request.

(b) The patient handout builder requests knowledge from multiple resources as described in Section 2.1 considering the conditions and medications that are present in the patient's record.
(c) The resources respond as in Section 2.1. The patient education builder presents the retrieved patient education topics to Dr. Jones.
(d) Dr. Jones selects the relevant topics for her patient, potentially modifying the content, and adding notes.
(e) Finally, Dr. Jones offersthe handout to the patient (e.g., via printed copy, e-mail, personal health record).

2.3 Knowledge RetrievalInteraction

The following interactions refer to the scenarios described in Sections2.1 and 2.2. The interactions provide a comprehensive view of the process involving the communication betweena CIS system and one or multiple knowledge resources.Most knowledge integration implementations follow one of two architecture approaches: 1) direct communication between a CIS and a knowledge resource (Figure 1); 2) communication between a CIS and multiple knowledge resources through a knowledge broker known as Infobutton Manager[2] (Figure 2).

The interaction steps and corresponding service payload components are listed in the tables and figures below. Table 1and Figure 1depict a direct interaction between a CIS and a knowledge resource. Table 2 and Figure 2depict an interaction between a CIS and multiple knowledge resources mediated by Infobutton Manager.

Step	Description	Payload
1	A CIS sends a *knowledgeRequest* with context information to a knowledge resource.	HL7 International *Context-aware Knowledge Retrieval, Knowledge Request* Standard.
2	The knowledge resource sends back a *knowledgeResponse*to the CIS.	Text/html or HL7 International *Context-aware Knowledge Retrieval, Knowledge Response Standard* (described in Section 4 of the present specification).

Table 1 –Context-aware knowledge retrieval interaction without an Infobutton Manager.

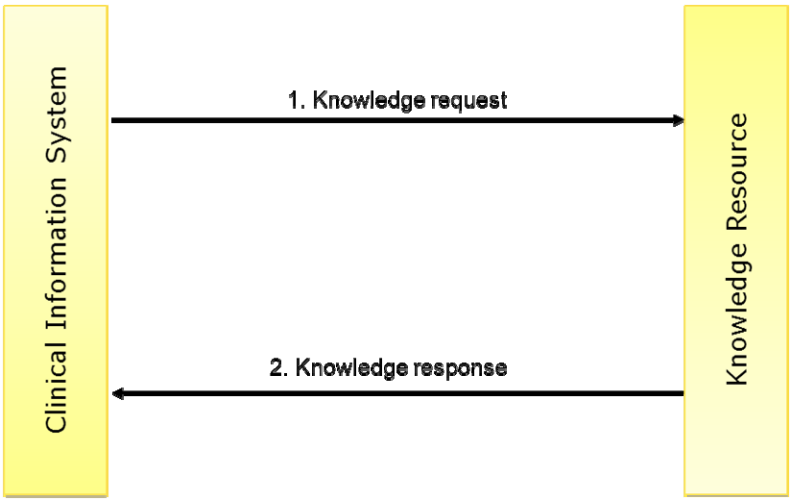

Figure 1– Context-aware knowledge retrieval interaction without an Infobutton Manager.

Step	Description	Payload
1	A CIS sends a *knowledgRequest* with context information to an Infobutton Manager.	HL7 International *Context-aware Knowledge Retrieval, Knowledge Request* Standard.
2	The Infobutton Manager sends a *knowledgeRequest*to multiple knowledge resources. Although the payload information model for items (1) and (2) is the same, the Infobutton Manager may refine the contents of the knowledge request based on user input or internal heuristics.	HL7 International *Context-aware Knowledge Retrieval, Knowledge Request* Standard.
3	Each knowledge resource sends back a *knowledgeResponse*to the Infobutton Manager.	Text/html or HL7 International *Context-aware Knowledge Retrieval, Knowledge Response Standard* (knowledge response payload, described in Section 4 of the present specification).
4	The Infobutton Manager sends to the CIS an aggregateKnowledgeResponse, which is composed of an aggregate of knowledge responses from one or more knowledge resources. .	Text/html or HL7 International *Context-aware Knowledge Retrieval, Knowledge Response Standard* (*aggregate knowledge response* payload,described in Section 4 of the present specification). The *aggregate knowledge response*payload information model is composed of one or more *knowledge response*instances wrapped by a single element.

Table 2 –Context-aware knowledge retrieval interaction with an Infobutton Manager.

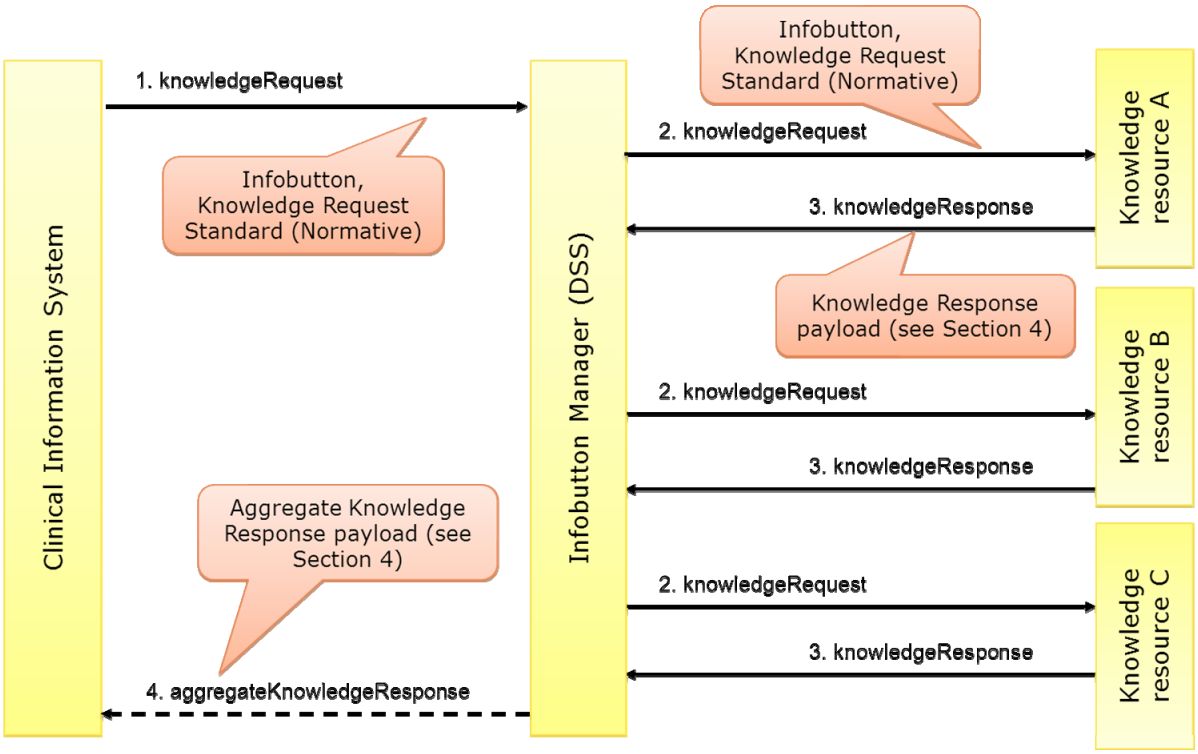

Figure 2–Context-aware knowledge retrieval interaction with an Infobutton Manager.

Pending issue: The present specification assumes that an Infobutton Manager implementation SHALLwait until it receives for responses (or a request times out) from every resource before it sends a final aggregateKnowledgeResponseback to a CIS client. Yet, we acknowledge that additional desired behaviors may arise during the DSTU period. For example, an Infobutton Manager could send multiple interim aggregate knowledge responses responses back to the CIS client as it receives individual knowledge responses back from each knowledge resource. If desired, these additional behaviors will be assessed and guidance regarding these behaviors will be included in the implementation guide prior to final publication.

3 SOA Context-Aware Knowledge Retrieval

The present Implementation Guide offers two SOA-based knowledge integration alternatives: The first one is based on the SOAP protocol and the HL7 International/OMG DSS Standard (Section 3.1). The second one is based on the RESTsoftware architecture style (Section 3.2). In both implementation approaches, Infobutton Managers and knowledge resources are considered to be knowledge retrieval service instances that receive a context-aware knowledge request and reply with an aggregate knowledge response and a knowledge response respectively.

3.1 DSS-based Implementation

A DSS can be conceptually understood as the guardian of one or more modules of medical knowledge, wherein each DSS knowledge module is capable of utilizing coded patient data to arrive at machine-interpretable conclusions regarding the patient under evaluation. The scope of a typical DSS knowledge module is the assessment of a single patient in a specified topic area. The topic area may be narrow (e.g., the need for a glycated hemoglobin test for a patient with diabetes) or broad (e.g., retrieval of context-sensitive knowledge). In the context of this present specification, both Infobutton Managers and knowledge resources MAY be implemented as knowledge modules of a DSS.

The DSS-based implementation is a constraint over the *HL7 DSS Service Functional Model Specification. Draft Standard for Trial Use - Release 1* and the *OMG CDSS Specification Version 1.0.*[5,6]

The HL7 DSS/OMG DSS Standard provides a generic framework for the implementation of clinical decision support (CDS) capabilities over a SOA. The advantage of using a common generic framework for CDS capabilities, including but not limited to knowledge retrieval, is that a variety of these capabilities (e.g., drug interaction checking, infobuttons, chronic disease management) can be accessed through a common standard mechanism.

Specific uses of the DSS Standard are accomplished through the definition of *DSS Profiles*. DSS Profiles are a mechanism defined in the HL7 DSS specification (HL7 DSS, Section 6) to allow a DSS to be constrained to the degree required for implementation and interoperability of a given type of service, such as the Context-Aware Knowledge RetrievalDSS described in this Section. The OMG DSS specification describes two functional profiles: the *HSSP Simple Evaluation DSS Functional Profile* and the *HSSP Complete DSS Functional Profile*.

Knowledge Resource and Infobutton Manager DSS implementations SHALL conform at least to the requirements of the “HSSP Simple Evaluation DSS Functional Profile” (OMG DSS, Section 6.10.2).A brief description of this profile, along with examples,isavailable in Section 3.1.3. Moreover, a Knowledge Resource DSS will also need to comply with the *HL7 Knowledge Resource DSS Conformance Profile*, (Section3.1.1) which will place additional constraints on the allowed service payloads. Likewise, an Infobutton Manager DSS needs to comply with the *HL7 Infobutton Manager DSS Conformance Profile* (Section3.1.2).

3.1.1 HL7 Knowledge Resource DSS Conformance Profile

To claim conformance to the HL7 Knowledge ResourceDSS Conformance Profile, a Knowledge Resource SHALL support the requirements of the HSSP Simple Evaluation DSS Conformance Profile as well as the HL7 Knowledge Resource DSS Semantic Profile. The HL7 Knowledge Resource DSS Semantic Profile consists of a semantic requirement that:

1. The payload in the evaluation request SHALL be represented using the *HL7 Context-aware Knowledge Retrieval (“Infobutton”), Knowledge Request Standard*;
2. The payload in the evaluation result SHALL be returned using the *HL7 Context-aware Knowledge Retrieval (“Infobutton”), Knowledge Response Standard* specified in Section 4.

3.1.2 HL7 Infobutton Manager DSS Conformance Profile

To claim conformance to the HL7 Infobutton ManagerDSS Conformance Profile, anInfobutton ManagerSHALL support the requirements of the HSSP Simple Evaluation DSS Conformance Profile as well as the HL7 Infobutton ManagerDSS Semantic Profile. The HL7 Infobutton ManagerDSS Semantic Profile consists of a semantic requirement that:

1. The payload in the evaluation request SHALL be represented using the *HL7 Context-aware Knowledge Retrieval ("Infobutton"), Knowledge Request Standard*;
2. The payload in the evaluation result SHALL be returned using the *HL7 Context-aware Knowledge Retrieval ("Infobutton"), Aggregate Knowledge Response Standard* specified in Section 4.

3.1.3 HSSP Simple Evaluation DSS Functional Profile

To claim conformance to the HSSP Simple Evaluation DSS Functional Profile, a DSS SHALL implement the *evaluate* DSS operation of the OMG DSS *Evaluation*interface. The *evaluate*operation allows a client to submit arequest for a specific CDScapability (e.g., knowledge retrieval) to a DSS instance and receive a CDS response back (e.g., relevant content retrieved by a knowledge resource). The OMG DSS Simple Evaluation Functional ProfileWSDL(dssEvaluate.wsdl) file and other DSS machine readable files are available elsewhere.[7]

The *evaluate* operation takes an *EvaluationRequest* object (OMG DSS, Section 6.6.1) as a payload and receives back an *EvaluationResponse* object (OMG DSS, Section 6.6.2). For the Knowledge ResourceDSS, the payload component of the *EvaluationRequest* object is specified in the *HL7 Context-Aware Knowledge Retrieval ("Infobutton"), Knowledge Request Standard*.[3] The payload component of the *EvaluationResponse* object is proposed in Section 4 of the present document. In terms of the nomenclature used throughout this present specification, *EvaluationRequest* is an implementation of the Knowledge Request interaction described in Section 2.3.The EvaluationResponse object is an implementation of the Knowledge Response interaction.

3.1.4 WSDL Specification

The following sections describethe components of an *evaluate* operation instance.Items of an*EvaluationRequest*instance are described in Section 3.1.4.1and Items of an*EvaluationResponse*instance are described in Section 3.1.4.2. The OMG DSS Simple Evaluation Functional Profile WSDL is available elsewhere.[7]

3.1.4.1 Evaluation request

Figure 3shows an example of a Knowledge Retrieval DSS *EvaluationRequest* XML instance. The example is used to illustrate how to construct a Knowledge Retrieval DSS EvaluationRequest by following the set of rules described below. Each rule refers to a fragment of the example.

A Knowledge Retrieval or Infobutton Manager DSS*EvaluationRequest*is composed of the following sections:

1. A SOAP wrapper, with a SOAP header and a SOAP body
2. In the SOAP body, a DSS *evaluate* operation node.

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:dss="http://www.omg.org/spec/CDSS/201012/dss">
    <SOAP-ENV:Body>
        <dss:evaluate>
            <interactionId scopingEntityId="edu.duke" interactionId="123456789"
            submissionTime="2010-11-01T10:21:22"/>
            <evaluationRequest clientLanguage="en-us" clientTimeZoneOffset="-05:00">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="gov.nih.nlm" businessId=
                    "HL7KnowledgeRetrievalModule201101" version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="HL7KnowledgeRequestPayload">
                        <containingEntityId scopingEntityId="gov.nih.nlm" businessId=
                        "HL7KnowledgeResourceModule201101" version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId=
                        "org.hl7.v3.multicacheschemas" businessId=
                        "REDS_MT010001UV.REDS_MT010001UV.KnowledgeRequestNotification"
                         version="1.0.0"/>
                        <base64EncodedPayload>
                        UjBsR09EbGhjZ0dTQUxNQUFBUUNBRU1tQ1p0dU1GUXhEUzhi
                        </base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluate>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Figure 3– ADSS EvaluationRequestexample that calls a knowledge resource DSS.

The following rules specify how to create an XML instance of a DSS EvaluationRequest:

1. The evaluate element SHALL be prefixed with a namespace labeled*dss*as follows:

```
<SOAP-ENV:Envelopexmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
xmlns:dss="http://www.omg.org/spec/CDSS/201012/dss">
        <SOAP-ENV:Body>
            <dss:evaluate>
```

2. The *interactionId* element SHALL be used for the client to uniquely identify a knowledge retrieval session (e.g., for debugging or logging purposes). The combination of the attributes *scopingEntityId* and *interactionId* SHALL be used to guarantee uniqueness.

```
<dss:evaluate>
        <interactionIdscopingEntityId="edu.duke"interactionId="123456789"submissionTime="20
10-11-01T10:21:22"/>
```

   Note about scopingEntityId attributes: The *scopingEntityId*SHALL start with lowercase English representations of one of the top-level Internet domain names, currently com, edu, gov, mil, net, org, or one of the English two-letter codes identifying countries as specified in ISO Standard 3166-1. Subsequently, the “id” SHALL start by defining the domain name that is associated with the scoping entity (e.g., “gov.nlm.nih,” “gov.vha,” “edu.duke,” “org.hl7”). Subsequent identification within the domain associated with the scoping entity, if any, MAY be specified as is appropriate for the internal naming conventions by the scoping entity.

3. The *evaluationRequest* element SHALL specify the preferred human language of the client application in the *clientLanguage* attribute.Language SHALL be specified as either a 2-character ISO 639-1 language code or a combination of a 2-character ISO 639- 1 language code and a 2-

http://www.iso.org/iso/english_country_names_and_code_elements.

4. The *evaluationRequest* element SHALL specify the client's time zone offset in the *clientLanguage* attribute.Time zone offset SHALL be specified from Universal Coordinated Time (UTC). This offset is expressed as +/- hh:mm, e.g., 00:00, -05:00, +07:00.

```
<evaluationRequestclientLanguage="en-us"clientTimeZoneOffset="-05:00">
```

5. The type of knowledge module being called (i.e., knowledge retrieval module compliant with this present specification) by the client SHALL be specified in the *kmEvaluationRequest.kmId* element.
    a. The attribute *scopingEntityId* SHALL be the organization that hosts the knowledge retrieval service.
    b. To call a *knowledge resource* DSS implementation, the attribute businessId SHALL be fixed to *HL7KnowledgeResourceModule201101*.
    c. To call an *infobutton manager* DSS implementation, the attribute businessId SHALL be fixed to *HL7InfobuttonManagerModule201101*.
    d. The *version* attribute MAY be used by the client to indicate that a specific version of a knowledge retrieval service is to be used to respond to the EvaluationRequest.

```
To call a Knowledge Resource DSS:
<kmEvaluationRequest>
        <kmIdscopingEntityId="gov.nih.nlm"businessId="HL7KnowledgeResourceModule201101
" version="1.0.0"/>
</kmEvaluationRequest>

To call an Infobutton Manager DSS:
<kmEvaluationRequest>
        <kmIdscopingEntityId="gov.nih.nlm"businessId="HL7InfobuttonManagerModule201101"
version="1.0.0"/>
</kmEvaluationRequest>
```

6. A specification of the data required by the knowledge module SHALL be represented in the dataRequirementItemData.driId element.
    a. The itemId attribute SHALL be fixed to *HL7KnowledgeRequestPayload*.
    b. The *containingEntityId* element SHALL contain the same values as the *kmId* element defined above. The businessId attribute SHALL be fixed to HL7KnowledgeResourceModule201101, when calling a knowledge resource DSS, or HL7InfobuttonManagerModule201101, when calling an Infobutton Manager DSS.

```
To call a Knowledge Resource DSS:
<dataRequirementItemData>
        <driIditemId="HL7KnowledgeRequestPayload">

        <containingEntityIdscopingEntityId="gov.nih.nlm"businessId="HL7KnowledgeResourceM
odule201101" version="1.0.0"/>
        </driId>

To call an Infobutton Manager DSS:
<dataRequirementItemData>
        <driIditemId="HL7KnowledgeRequestPayload">

        <containingEntityIdscopingEntityId="gov.nih.nlm"businessId="HL7InfobuttonManagerMod
ule201101" version="1.0.0"/>
        </driId>
```

7. The information model used to represent the request data payload (i.e., the *HL7 Context-Aware Knowledge Retrieval, Knowledge Request* XML schema) SHALL be represented in the *data.informationModelSSId* element.
    a. The *scopingElementId* attribute SHALL be fixed to the location of the knowledge request payload XML schema, i.e.*org.hl7.v3.multicacheschemas*.
    b. The *businessId*attribute SHALL be fixed to a name composed of [name of the knowledge request payload XML schema].[knowledge request schema root element name], i.e. *REDS_MT010001UV.REDS_MT010001UV.KnowledgeRequestNotification.*
    c. The *version*attribute SHALL be used to indicate the version of the *Context Aware Knowledge Retrieval Standard, Knowledge Request*that is used to represent data in the *EvaluationRequest* payload.

```
<data>
        <informationModelSSIdscopingEntityId="org.hl7.v3.multicacheschemas"
businessId="REDS_MT010001UV.REDS_MT010001UV.KnowledgeRequestNotification"
version="1.0.0"/>
```

8. The *EvaluationRequest* data payload SHALL be included in the *base64EncodedPayload* element. As the element name indicates, the payload content SHALL be represented in base 64 encoding. <base64EncodedPayload>BASE64ENCODEDCONTENT</base64EncodedPayload>

3.1.4.2 Evaluation response

Figure 4 shows an example of a Knowledge Resource DSS *EvaluationResponse*XML instance. Like in the previous Section, the example is used to illustrate how to construct a DSS *EvaluationResponse* by following the set of rules described below.

A Knowledge Resource or Infobutton Manager DSS*EvaluationResponse*is composed of the following sections:

1. A SOAP wrapper, with a SOAP header and a SOAP body
2. In the SOAP body, a DSS *evaluateResponse*operation node.

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:dss="http://www.omg.org/spec/CDSS/201012/dss">
    <SOAP-ENV:Body>
        <dss:evaluate>
            <interactionId scopingEntityId="edu.duke" interactionId="123456789"
            submissionTime="2010-11-01T10:21:22"/>
            <evaluationRequest clientLanguage="en-us" clientTimeZoneOffset="-05:00">
                <kmEvaluationRequest>
                    <kmId scopingEntityId="gov.nih.nlm" businessId=
                    "HL7KnowledgeResourceModule201101" version="1.0.0"/>
                </kmEvaluationRequest>
                <dataRequirementItemData>
                    <driId itemId="HL7KnowledgeRequestPayload">
                        <containingEntityId scopingEntityId="gov.nih.nlm" businessId=
                        "HL7KnowledgeResourceModule201101" version="1.0.0"/>
                    </driId>
                    <data>
                        <informationModelSSId scopingEntityId=
                        "org.hl7.v3.multicacheschemas" businessId=
                        "REDS_MT010001UV.REDS_MT010001UV.KnowledgeRequestNotification"
                        version="1.0.0"/>
                        <base64EncodedPayload>BASE64ENCODEDCONTENT</base64EncodedPayload>
                    </data>
                </dataRequirementItemData>
            </evaluationRequest>
        </dss:evaluate>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Figure 4– AKnowledge Resource DSS EvaluationResponseexample.

The following rules specify how to create an XML instance of a DSS EvaluationResponse:

1. The evaluateResponse element SHALL be prefixed with a namespace labeled*dss*as follows:

```
<SOAP-ENV:Envelopexmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-
envelope"xmlns:dss="http://www.omg.org/spec/CDSS/201012/dss">
<SOAP-ENV:Body>
<dss:evaluateResponse>
```

2. The type of knowledge module called by the client and that provides the EvaluationResponseSHALL be specified in the *finalKMEvaluationResponse.kmId* element.
    a. The attribute *scopingEntityId* SHALL be the organization that hosts the knowledge retrieval service.
    b. For a Knowledge Resource DSS, the attribute businessId SHALL be fixed to *HL7KnowledgeResourceModule201101*.
    c. For an Infobutton Manager DSS, the attribute businessId SHALL be fixed to *HL7InfobuttonManagerModule201101*
    d. The *version* attribute MAY be used by the knowledge retrieval service to indicate the specific version of theknowledge modulethat responds to the knowledge request.

```
Knowledge Resource DSS:
<finalKMEvaluationResponse>
        <kmIdscopingEntityId="gov.nih.nlm"
        businessId="HL7KnowledgeResourceModule201101" version="1.0.0"/>

Infobutton Manager DSS:
<finalKMEvaluationResponse>
```

```
        <kmIdscopingEntityId="gov.nih.nlm"       businessId="HL7InfobuttonManager201101"
version="1.0.0"/>
```

3. A specification of the EvaluationResponse payload data SHALL be represented in the *evaluationResultId*element.
    a. For a Knowledge Resource DSS, the itemId attribute SHALL be fixed to *HL7KnowledgeResponsePayload*.
    b. For an Infobutton Manager DSS, the itemId attribute SHALL be fixed to *HL7AggregateKnowledgeResponsePayload*.
    c. The *containingEntityId* element SHALL contain the same values as the *kmId* element defined above.

```
Knowledge Resource DSS:
<kmEvaluationResultData>
        <evaluationResultIditemId="HL7KnowledgeResponsePayload">
                <containingEntityIdscopingEntityId="gov.nih.nlm"
        businessId="HL7KnowledgeResourceModule201101" version="1.0.0"/>
        </evaluationResultId>

Infobutton Manager DSS:
<kmEvaluationResultData>
        <evaluationResultIditemId="HL7AggregateKnowledgeResponsePayload">
                <containingEntityIdscopingEntityId="gov.nih.nlm"
        businessId="HL7InfobuttonManagerModule201101" version="1.0.0"/>
        </evaluationResultId>
```

4. The information model used to represent the EvaluationResponse data payload (i.e., the *HL7 Context-Aware Knowledge Retrieval, Knowledge Response* XML schema) SHALL be represented in the *data.informationModelSSId* element.
    a. The *scopingElementId* attribute SHALL be fixed to the location of the knowledge response payload XML schema, i.e. *org.hl7.v3.multicacheschemas*.
    b. The *businessId* attribute SHALL be fixed to a name composed of [name of the knowledge response payload XML schema].[knowledge response schema root element name], i.e. *KnowledgeResponse.feed*for theHL7KnowledgeResponsePayload; and *AggregateKnowledgeResponse.knowledgeResponse* for the HL7AggregateKnowledgeResponsePayload
    c. The *version* attribute SHALL be used to specify the version of the HL7 International *Context-aware Knowledge Retrieval, Knowledge Response Standard* used in the EvaluationResponse.

```
Knowledge Resource DSS:
<data>
        <informationModelSSIdscopingEntityId="org.hl7.v3"businessId="KnowledgeResponse.fe
ed" version="1.0.0"/>

Infobutton Manager DSS:
<data>
        <informationModelSSIdscopingEntityId="org.hl7.v3"
businessId="AggregateKnowledgeResponse.aggregateKnowledgeResponse" version="1.0.0"/>
```

5. The EvaluationResponse data payload SHALL be included in the *base64EncodedPayload* element. As the element name indicates, the payload content SHALL be represented in base 64 encoding.

```
<base64EncodedPayload>BASE64ENCODEDCONTENT</base64EncodedPayload>
```

3.2 RESTful Implementation

An alternative knowledge retrieval implementation is based on the REST software architecture style. To declare conformance with the RESTfulcontext-aware knowledge retrieval specification, implementers SHALL comply with the following:

1. The **knowledge request**SHALL be implemented according to at least one of the following mechanisms:
    a. URL according to the *HL7 International Context-Aware Knowledge Retrieval, URL-Based Implementation Guide*[4] using HTTP GET (Figure 5) or POST or;
    b. XML according to the *HL7 International Context-Aware Knowledge Retrieval, Knowledge Request Standard*[3]XML schemausing HTTP POST.
2. The **knowledge response**SHALL be implemented according to at least one of the following mechanisms:
    a. Knowledge Resource: *Knowledge Response* payload (specified in Section 4)
    b. Infobutton Manager:*AggregateKnowledge Response* payload (specified in Section 4)

NOTE: Implementers MAY still follow the widely adopted implementation approach, in which a knowledge request is compliant with the *HL7 International Context-Aware Knowledge Retrieval, URL-Based Implementation Guide*and knowledge responses are represented in HTML.The following dispositions apply:

1) The present SOA specification does not supersede the URL-based request/HTML response approach.
2) Implementations that follow the URL-based request/HTML response approach may claim compliance to the *HL7 International Context-Aware Knowledge Retrieval, URL-Based Implementation Guide*.
3) Implementations that only implement the URL-based request/HTML response approach cannot claim compliance to the present SOA specification.

3.2.1 Knowledge ResponseType parameter

In both knowledge request implementation alternatives, a parameter named *knowledgeResponseType* MAY be added to the knowledge request to specify the desired knowledge response type. The valid *knowledgeResponseType*values are: “text/html” and “text/xml”. If the *knowledgeResponseType*parameter is omitted, “text/html” SHALL be assumed as the default. As described above, implementations that only support a knowledgeResponseType of “text/html” MAY claim compliance to the *HL7 International Context-Aware Knowledge Retrieval, URL-Based Implementation Guide*, but cannot claim compliance to the RESTful implementation approach described in this Section.

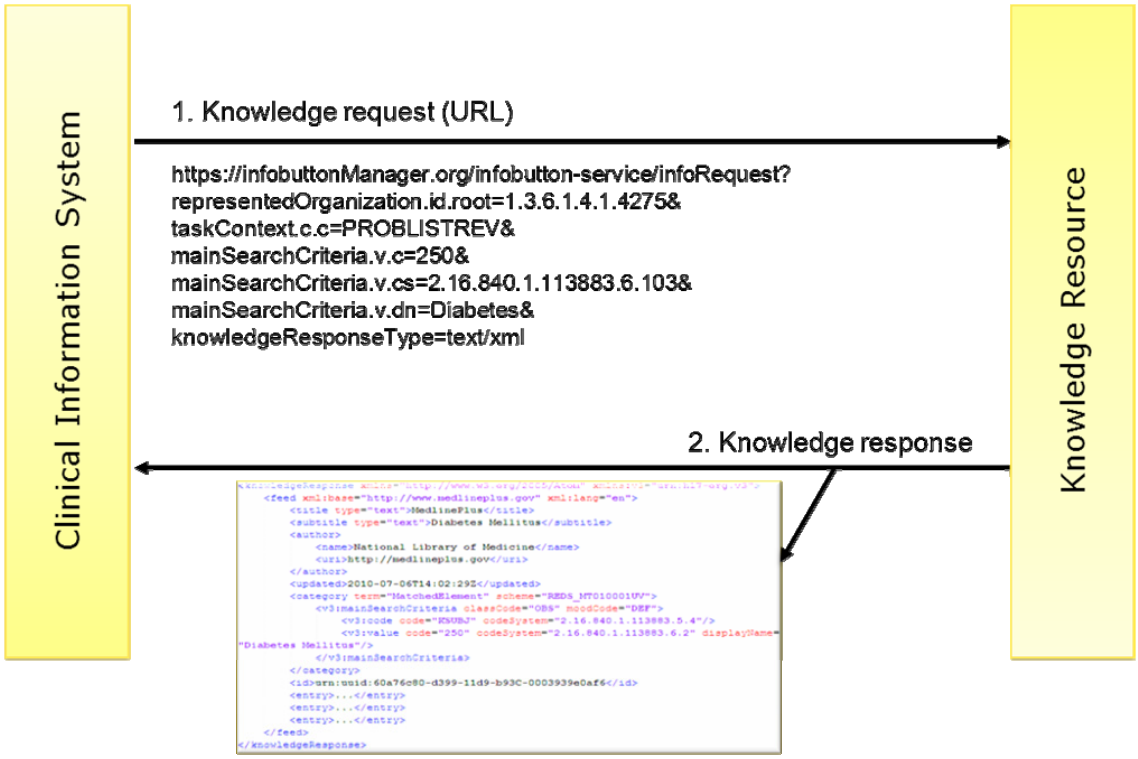

Figure 5 – A RESTful context-aware knowledge retrieval implementation with a URL-based knowledge request and an XML knowledge response.

4 Knowledge ResponsePayload

To identify potential standards that could be leveraged to support the functional and technical requirements of the knowledge response described in the previous sections, a survey of existing Web-based knowledge integration standards was conducted. Due to theirwide adoption andease of use, content syndication standards, such as RSS (Really Simple Syndication) and Atom, were raised as the primary candidates. The following sections compare the different content syndication standards explaining the rationale behind the choice of Atom as the framework for the *Knowledge Response* payload(Section 4.1);provide a brief overview of the Atom standard (Section 4.2); and provide a specification for the *Knowledge Response* payload (Section 4.2) and the Aggregate Knowledge Response payload (Section 4.3.).

4.1 Content Syndication Standards

Web-based content syndication is a form of syndication in which website material is made available to multiple other sites.[1] Most commonly, Web syndication refers to making Web feeds available from a site in order to provide other people with a summary of the Website's recently added content (for example, the latest news or forum posts). The term can also be used to describe other kinds of licensing Website content so that other Websites can use the content. The two main families of Web syndication formats are RSS[9] and Atom.[10]

	RSS 2.0	Atom
Format	XML	XML
Standard organization	Interest group (Harvard)	IETF (Internet Engineering Task Force – Internet Society)
Focus	Simplicity	Robustness
Extensibility	Informal	Formal, via namespaces and extension guidelines
Content structure	Plain text or HTML	Plain text, HTML, XHTML, XML, binary content, content pointer
Full content vs. partial content	No distinction	<summary> and <content> tags
Support for aggregate feeds	No	Yes
Publishing protocol	MetaWeblog, Blogger	Atom publishing protocol
Date published	2003	2005

Table 3 – Comparison between the RSS 2.0 and Atom Web syndication standards.

Through a comparison between RSS 2.0 and Atom, the CDS WG achieved a consensus that Atom has several advantages over RSS 2.0 when considering the requirements of this implementation guide:

- Unlike RSS 2.0, Atom has been developed and maintained by a formal standards development organization (IETF);
- Atom provides multiple mechanisms to enable extensions to its base model;
- Atom allows retrieved knowledge content to be represented in multiple formats, such as HTML, XHTML, XML, and binary.

4.2 Knowledge ResponsePayload

This section includes a brief overview of the Atom standardas well as extensions and restrictions regarding the use of particular Atom elements for the purpose of the *Knowledge Request* payload.

Descriptions of the Atom standard in this Section are provided for convenience. For acomplete specification of the Atom standard, implementers SHALL also refer to the official IETF Atom specification.[10]
The Knowledge Response payload described in the present Section SHALL be followed by Knowledge Resource implementations in their knowledge response interactions. Infobutton Managers SHALL use the Aggregate Knowledge Response payload described in Section 4.3.

4.2.1 Atom Overall Structure

Atom is organized in two main elements: *Atom:feed* and *Atom:entry*. *Feed* is the root element of an Atom instance. It contains metadata about a specific set of retrieved content, such as the content set title, author, id, and last update time. Table 3provides a list and a short description of the *Atom:feed* child elements. A feed contains one or more *Atom:entry* elements. Each *Atom:entry* contains metadata about a specific content item, a summary of the content, and optionally the complete content itself. The *Atom:entry*child elements include the *Atom:feed*child elements as well as the elements listed inTable 4.

Figure 6contains a feed XML instance showing the *Atom:feed* node and its children.Figure 7 shows the entry elementsof the feed inFigure 6.

Element	Cardinality	Description
id	1..1	A permanent,stable, and universally unique identifier for the feed. The *id* value SHALL be an URI/IRI[1] (refer to Atom specification for details). The id SHALL 1) be a valid URI/IRI; 2) be globally unique; and 3) never change.
title	1..1	Human-readable title for the feed. SHALL be used to represent the knowledge resource content collection name to be displayed to end-users (e.g., MedlinePlus).
subtitle	0..1	Human-readable subtitle for the feed. MAY be used to represent the high-level knowledge subject covered by the feed (e.g., Diabetes Mellitus).
updated	1..1	Last time the feed was modified.SHALL be used to indicate when the knowledge response was generated.
author	1..n	Author of the feed.SHALL be used to represent the knowledge resource publisher name (e.g., National Library of Medicine).
link	0..n	A pointer to a Web document that contains the feed. Includes the following attributes: *href*, *rel*, *hreflang*, *title*, *length.* - *href:* the link'sURI - *type*: format of the content pointed by the URI (e.g., text, html, xhtml, xml, binary MIME types) - *rel*: the link relation type. Possible values are: *alternate* = a link to an alternative version of the entry (e.g., full-text content, including multiple languages and formats); *related* = a link to other content, which is related to the content represented in a feed or entry; *self* = identifies a resource equivalent to the containingelement (e.g., the feed itself); *via* = identifies a resource that is the source of theinformation provided in the containing element. - *title*: a human-readable title for the link - *length*: number of characters contained in the complete content represented in a particular feed.
category	0..n	Content classification that applies to all entries in a particular knowledge response. The present specification provides a domain-specific extension for the *Atom:category* element derived from the HL7 *Context-Aware Knowledge Retrieval, Knowledge Request*

[1] A useful tutorial on unique URIs is available at http://diveintomark.org/archives/2004/05/28/howto-atom-id

Element	Cardinality	Description
		RMIM (see Section 4.2.3.1 for details).
Icon	0..1	An icon to be display associated with the feed. MAY be used to represent an image that knowledge consumers are familiar with, such as a knowledge resource publisher or content collection icon.
Entry	0..n	Metadata about a specific piece of content, a summary of the content, and optionally the complete content itself. Each piece of content (e.g., document, image) retrieved by a knowledge resource in a knowledge response SHALL be represented as a distinct entry element.

Table 4 – Description of the *Atom:feed* nodeelements.

Element	Cardinality	Description
id	1..1	A permanent, universally unique identifier for the entry. The *id* value SHALL be an URI/IRI (refer to Atom specification for details). Updated versions of the same entry SHALL have the same *entry.id*, with a different *entry:updated* element.
title	1..1	Human-readable title for the entry. SHALLbe used to convey a title that can be displayed to the end-user (e.g., as a hyperlink label).
updated	1..1	Last time the entrywas modified.SHALL use to indicate when the entry was generated.
author	0..n	Author of the content associated with the entry. MAY use the name of the knowledge resource publisher (e.g., National Library of Medicine, American College of Physicians), a committee/group in charge of content creation, or the name of one or more individuals in charge of content creation.
link	1..n	A pointer to a Web document that contains the content associated with the entry. See Table 4 for a complete description.
category	0..n	Specific category that applies to a particular entry. For example, an entry may refer to content on *contraindications* of a medication, while another entry in the same feed may provide *dosing information* on the same medication.
summary	0..1	A short summaryof the contentassociated with the entry. The content MAY be represented in several formats, such as text, html, xhtml, XML, and binary MIME types.
content	0..1	The complete content associated with entry. The content MAY be represented in several formats, such as text, html, xhtml, XML, and binary MIME types.

Table 5 – Description of the *Atom:entry* nodeelements.

```
<feed xmlns:v3="urn:hl7-org:v3" xmlns="http://www.w3.org/2005/Atom" xml:base=
"http://www.nlm.nih.gov/medlineplus/">
    <title type="text">MedlinePlus</title>
    <subtitle type="text">Diabetes Mellitus</subtitle>
    <author>
        <name>National Library of Medicine</name>
        <uri>http://medlineplus.gov</uri>
    </author>
    <updated>2010-07-06T14:02:29Z</updated>
    <category term="MATCHED" scheme="REDS_MT010001UV">
        <v3:mainSearchCriteria classCode="OBS" moodCode="DEF">
            <v3:code code="KSUBJ" codeSystem="2.16.840.1.113883.5.4"/>
            <v3:value code="250" codeSystem="2.16.840.1.113883.6.2" displayName=
            "Diabetes Mellitus"/>
        </v3:mainSearchCriteria>
        <v3:informationRecipient typeCode="IRCP">
            <v3:patient classCode="PAT"/>
        </v3:informationRecipient>
    </category>
    <id>urn:uuid:60a76c80-d399-11d9-b93C-0003939e0af6</id>
    <entry>...</entry>
    <entry>...</entry>
    <entry>...</entry>
</feed>
```

Figure 6 –A feedfragment that contains multiple entries on Diabetes Mellitus.The children of the *category* element (prefixed with the *v3* namespace) are all derived from the HL7 *Context-Aware Knowledge Retrieval, Knowledge Request*RMIM.In this example, the *Atom:category* element indicates that the overall feed subject is “Diabetes Mellitus.” The *Atom:entry* elements are collapsed in this fragment, but expanded in Figure 7.

```
<entry>
    <title>diabetic diet</title>
    <link href="http://www.nlm.nih.gov/medlineplus/diabeticdiet.html" rel="alternate"
    type="html"/>
    <id>tag:nlm.nih.gov,2011-15-02:/medlineplus/diabeticdiet.html</id>
    <updated>2011-15-02T00:00:00Z</updated>
    <summary type="html">If you have diabetes, your body cannot make or properly use
    insulin.  This leads to high blood glucose, or sugar, levels in your blood. Healthy
    eating helps to reduce your blood sugar.  It is a critical part of managing your
    diabetes, because controlling your blood sugar can prevent the &lt;
    href="http://www.nlm.nih.gov/medlineplus/diabetescomplications.html">complications
    of diabetes &lt;/a>.</summary>
</entry>
<entry>
    <title>diabetic foot</title>
    <link href="http://www.nlm.nih.gov/medlineplus/diabeticfoot.html" rel="alternate"
    type="html"/>
    <id>tag:nlm.nih.gov,2011-02-11:/medlineplus/diabeticfoot.html</id>
    <updated>2011-02-11T00:00:00Z</updated>
    <summary type="html">If you have &lt;a
    href="http://www.nlm.nih.gov/medlineplus/diabetes.html">diabetes&lt;/a>, your blood
    sugar levels are too high.  Over time, this can damage your nerves or blood vessels.
    </summary>
</entry>
```

Figure 7 – Two *Atom:entry*nodes from the feed depicted inFigure 6. Each entry contains an *Atom:summary* and an *Atom:link* to the complete source content.

4.2.2 Atom Domain-Specific Extensions

An important feature of Atom is theability to define domain-specific extensions via namespaces and extension guidelines. Most of the Atom elements allow the addition of domain-specific children that are imported from external schemas. In addition, valuesused in Atom instances can be drawn from standard domain-specific taxonomies.

For the knowledge response payload, the Atom *category* element is extended to enable retrieved content to be categorized in terms of elements of the *HL7 Context-aware Knowledge Retrieval, Knowledge Request Standard*information model. Figure 6shows the fragment of a knowledge response payload in which the feed provides content that meets the need of a knowledge request in which the *mainSearchCriteria* is “Diabetes mellitus.”

4.2.3 Atom and the Knowledge Response Payload

When preparing or parsing a knowledge response payload, knowledge response implementers SHALL comply withthe specifications provided in Table 4 and Table 5 and the following specifications:

1. The root element of the knowledge response payload SHALL be the Atom:feed element.
2. A knowledge responseSHALL contain one and no more than one *Atom:feed* element.
3. Each individual piece of content (e.g., document, image) retrieved by a knowledge resource SHALL be represented as a distinct*Atom:entry* element. A knowledge resource that contains no content that matches a knowledge request SHALL produce a knowledge response payload with one *Atom:feed*element with no *Atom:entry* elements.
4. The retrieved content MAY be classified using the *Atom:category* elementaccording to the *Atom:category* domain-specific extension described below in Section 4.2.3.1.
5. Feed content SHALL contain metadata describing the human language in which a feed, segments of a feed, and links within a feed are written. Language representation SHALL follow a restriction over the Atom specification specified below in Section 4.2.3.2.
6. Knowledge resources SHALL include at least one *Atom:link* element per *Atom:entry* and knowledge requestors SHALL be able to process the *Atom:link* element.

4.2.3.1 *Atom:category*domain-specific extension

This Section specifies a domain-specific extension of the *Atom:category* element for the *Context-Aware Knowledge Retrieval DSS* knowledge response payload.The domain-specific extension enables feed content to be classified according to classes defined in the *HL7 Context-aware Knowledge Retrieval, Knowledge Request Standard*RMIM.More specifically:

1. The *scheme* attribute of *Atom:category* SHALL be fixed to the unique identifier (*REDS_MT010001UV)* of the *HL7 Context-aware Knowledge Retrieval, Knowledge Request Standard*RMIM.
2. The following classes of the *HL7 Context-aware Knowledge Retrieval, Knowledge Request Standard* RMIMand their associations MAY be included as children of *Atom:Category* elements:*mainSearchCriteria*, *subTopic*, *taskContext*, *patientContext*, *performer*, *informationRecipient*, and *encounter*.
3. HL7 knowledge request elements that are instantiated in the knowledge response SHALL be prefixed with the *v3* XML namespace.
4. Classifications defined in the *feed.category*element apply to the entire feed including all *Atom:entry* elements.Therefore,*Atom:entry* elements implicitly inherit the *feed.category* element classifications and implementers SHOULD NOT redundantly clone classifications defined at the feed level to the feed's *Atom:entry* elements. For example, in a knowledge request where *mainSearchCriteria* consists of one single medication, this *mainSearchCriteria*classification instance SHOULD be represented onlyat the *Atom:feed* level, implying that this classification applies to all entries.
5. Entries in a feed SHOULD have a classification. To represent classification(s), one of the two representation options SHALL be followed:
    - A broad classification for the entire feed is inherited from the category element atthe*Atom:feed*level;
    - All *Atom:entry* elements contain a specific classification defined by each entry's*Atom:category*.
6. The *term* attribute of *Atom:category*instances MAY be used to further specify whether the classification defined in a category instance matches one of the elements of a knowledge request or not. The *term* attribute SHOULD take one of the following values:
    - *MATCHED*: indicates that classification elementsof the *Atom:category*instance are included in the knowledge request AND their values match the values in the knowledge request.
    - *UNMATCHED:* indicates that classification elements of the *Atom:category* instance are included in the knowledge request but their values do not match the values in the knowledge request.
    - *OTHER*:indicates that classification elements of the *Atom:category* instance are not included in the knowledge request.

Figure 8shows a feed that illustrates the use of classification categories both at the feed and element level as well as different uses of the *Atom:categoryterm* attribute.

```
<feed xmlns:v3="urn:hl7-org:v3" xmlns="http://www.w3.org/2005/Atom" xml:base=
"http://www.nlm.nih.gov/medlineplus/">
    <title type="text">MedlinePlus</title>
    <subtitle type="text">Diabetes Mellitus</subtitle>
    <author>
        <name>National Library of Medicine</name>
        <uri>http://medlineplus.gov</uri>
    </author>
    <updated>2010-07-06T14:02:29Z</updated>
    <category term="MATCHED" scheme="REDS_MT010001UV">
        <v3:mainSearchCriteria classCode="OBS" moodCode="DEF">
            <v3:code code="KSUBJ" codeSystem="2.16.840.1.113883.5.4"/>
            <v3:value code="250" codeSystem="2.16.840.1.113883.6.2" displayName=
            "Diabetes Mellitus"/>
        </v3:mainSearchCriteria>
        <v3:informationRecipient typeCode="IRCP">
            <v3:patient classCode="PAT"/>
        </v3:informationRecipient>
    </category>
    <id>urn:uuid:60a76c80-d399-11d9-b93C-0003939e0af6</id>
    <entry>
        <title>diabetic diet</title>
        <link href="diabeticdiet.html" rel="alternate" type="html"/>
        <id>tag:nlm.nih.gov,2011-15-02:/medlineplus/diabeticdiet.html</id>
        <updated>2011-15-02T00:00:00Z</updated>
        <summary type="html">If you have diabetes, your body cannot make or properly use
        insulin.  This leads to high blood glucose, or sugar, levels in your blood.
        </summary>
    </entry>
    <entry>
        <title>diabetic foot</title>
        <link href="diabeticfoot.html" rel="alternate" type="html"/>
        <id>tag:nlm.nih.gov,2011-02-11:/medlineplus/diabeticfoot.html</id>
        <updated>2011-02-11T00:00:00Z</updated>
        <summary type="html">If you have diabetes, your blood sugar levels are too
        high.  Over time, this can damage your nerves or blood vessels.  Nerve damage
        from diabetes can cause you to lose feeling in your feet.</summary>
        <category term="UNMATCHED" scheme="REDS_MT010001UV">
            <v3:mainSearchCriteria classCode="OBS" moodCode="DEF">
                <v3:code code="KSUBJ" codeSystem="2.16.840.1.113883.5.4"/>
                <v3:value code="250.7" codeSystem="2.16.840.1.113883.6.2" displayName=
                "Diabetes with peripheral circulatory disorders"/>
            </v3:mainSearchCriteria>
        </category>
    </entry>
</feed>
```

Figure 8 –Fragment of a knowledge response payload instance in response to a knowledge request that conveys a patient with diabetes mellitus and the need for patient education content. The response includes a feed with an*Atom:category*element indicating that all feed entries contain content on the subject “diabetes mellitus” (*mainSearchCriteria* tag) and that the content is written for patient (*informationRecipient* tag). The feed also includes one*Atom:entry* element that covers the specific subject “diabetes with peripheral circulatory disorders.”

4.2.3.2 Restrictions in the use of *xml:lang* and *hreflang* attributes

According to the Atom specification, any text-based Atom element (e.g., title, summary, content) may use the xml:lang attribute to specify the human language in which the text is written. Likewise, *link* instances may use the *hreflang* attribute to specify the human language of the content pointed by the *link*href

attribute. As a result, content language may be specified at various levels, increasing flexibility but creating unnecessarycomplexity for implementations, which need to account for all possible variations.

To limit unnecessary flexibility, knowledge response implementers SHOULD consider the following three use cases when representing and processing human language in a knowledge response:

1. The entire feed is provided in one single language: the language SHOULD be specified onlyat the root *Atom:feed*element level (Figure 9).
2. All entriesare provided primarily in one single language, but alternate content is available in other languages via alternate *link* elements: the primary language SHOULD be specified at the root *Atom:feed*element level AND the language of each *entry.link*SHOULD be specified at the level of each *entry.link*element (*hreflang* attribute) (Figure 10).
3. The feed contains entries in multiple languages (i.e., each entry has corresponding entries of the same content in other languages): language SHOULD be specified at the level of each Atom.entry element (xml:lang attribute) (Figure 11).

Therefore, knowledge response implementers MAY represent human language only at three specific levels as opposed to any text-based element: 1) *xml:lang* at the root *Atom:feed* element level; 2) *xml:lang* at the *Atom:entry* element level; and 3) *hreflang* at the level of each *entry.link* element. Other feed elements SHOULD not contain a language attribute.

```
<feed xmlns:v3="urn:hl7-org:v3" xmlns="http://www.w3.org/2005/Atom" xml:base=
"http://www.nlm.nih.gov/medlineplus/" xml:lang="en">
    <title type="text">MedlinePlus</title>
    <subtitle type="text">Diabetes Mellitus</subtitle>
    <author>
        <name>National Library of Medicine</name>
        <uri>http://medlineplus.gov</uri>
    </author>
    <entry>
        <title>Diabetic diet</title>
        <link href="diabeticdiet.html" rel="alternate" type="html"/>
        <id>tag:nlm.nih.gov,2011-15-02:/medlineplus/diabeticdiet.html</id>
        <updated>2011-15-02T00:00:00Z</updated>
        <summary type="html">If you have diabetes, your body cannot make or
        properly use insulin.  This leads to high blood glucose, or sugar,
        levels in your blood. </summary>
    </entry>
</feed>
```

Figure 9 –Fragment of a knowledge response payload instance in which the entire content is written in English. The *xml:lang* attribute is set at the *Atom:feed* level only.

```
<feed xmlns:v3="urn:hl7-org:v3" xmlns="http://www.w3.org/2005/Atom" xml:base=
"http://www.nlm.nih.gov/medlineplus/" xml:lang="en">
    <title type="text">MedlinePlus</title>
    <subtitle type="text">Diabetes Mellitus</subtitle>
    <author>
        <name>National Library of Medicine</name>
        <uri>http://medlineplus.gov</uri>
    </author>
    <entry>
        <title>Diabetic diet</title>
        <link href="diabeticdiet.html" rel="alternate" type="html" hreflang="en"/>
        <link href="spanish/diabeticdiet.html" rel="alternate" type="html"
        hreflang="sp"/>
        <id>tag:nlm.nih.gov,2011-15-02:/medlineplus/diabeticdiet.html</id>
        <updated>2011-15-02T00:00:00Z</updated>
        <summary type="html">If you have diabetes, your body cannot make or
        properly use insulin.  This leads to high blood glucose, or sugar, levels
        in your blood. </summary>
    </entry>
</feed>
```

Figure 10 –Fragment of a knowledge response payload instance in which the content is written in English, but links to source content are provided in both English and Spanish. The *xml:lang* attribute is set at the *Atom:feed* level and the *hreflang* attribute is set at the level of each *Atom:link*.

```
<feed xmlns="http://www.w3.org/2005/Atom" xmlns:v3="urn:hl7-org:v3" xml:base=
"http://www.nlm.nih.gov/medlineplus/">
        <title type="text">MedlinePlus</title>
        <subtitle type="text">Diabetes Mellitus</subtitle>
        <author>
            <name>National Library of Medicine</name>
            <uri>http://medlineplus.gov</uri>
        </author>
        <id>urn:uuid:60a76c80-d399-11d9-b93C-0003939e0af6</id>
        <updated>2010-07-06T14:02:29Z</updated>
        <entry xml:lang="en">
            <title>diabetic diet</title>
            <link href="diabeticdiet.html" rel="alternate" type="html"/>
            <id>tag:nlm.nih.gov,2011-15-02:/medlineplus/diabeticdiet.html</id>
            <updated>2011-15-02T00:00:00Z</updated>
            <summary type="html">If you have diabetes, your body cannot make or properly
            use insulin.  This leads to high blood glucose, or sugar, levels in your
            blood.</summary>
        </entry>
        <entry xml:lang="sp">
            <title>Dieta para diabéticos</title>
            <link href="spanish/diabeticdiet.html" rel="alternate" type="html"/>
            <id>tag:nlm.nih.gov,2011-01-07:/medlineplus/spanish/diabeticdiet.html</id>
            <updated>2011-01-07T00:00:00Z</updated>
            <summary type="html">Si tiene diabetes, su cuerpo no puede producir o
            utilizar la insulina adecuadamente. Esto conduce a una elevación del nivel
            de glucosa (azúcar) en la sangre.</summary>
        </entry>
    </feed>
</feed>
```

Figure 11 –Fragment of a knowledge response payload instance that has one entry in English and one entry in Spanish. The *xml:lang* attribute is set at the level of each *Atom:entry*element.

4.3 Aggregate Knowledge Response Payload

The Aggregate Knowledge Response payload is identical to the Knowledge Response payload defined in Section 4.2, except for the following:

1. The root element of the knowledge response payload SHALL be called *aggregateKnowledgeResponse*.
2. A knowledge response payload SHALL contain at least one *Atom:feed* element that is a child of the root *aggregateKnowledgeResponse* element.
3. A knowledge response MAY contain multiple *Atom:feed* elements. For example, an Infobutton Manager MAY create a knowledge response with one *Atom:feed* element per knowledge resource. Similarly, a multidatabase knowledge resource MAY create a knowledge response with one *Atom:feed* element for each database represented in the response.

5 Examples

The following examples illustrate hypothetical knowledge integration scenarios. Each example contains a narrative description andreferences to an XML knowledge request payload and an XML knowledge response payload. XML payload instances and XML schemas are available in the zip file that contains this specification.

5.1 Example 1

Knowledge Request: A registered nurse, English speaker, reviewing a problem list of a male, 45 years old patient, who has diabetes mellitus. The nurse wishes to wants retrieve patient-specific education material to be given to the patient.

Knowledge Response: A knowledge resource (MedlinePlus) specialized in consumer health information retrieves a knowledge response with two potentially relevant entries: “diabetic diet“ and “diabetic foot.“ The overall language of the response is English (see *feed.xml:lang* attribute), which is the language of the knowledge request performer. However, since the knowledge request did not specify the information recipient’s language, each response entry also contains an alternate link to content in Spanish (see *link.hreflang*attributes).

The overall feed is tagged with a category element that conveys “patient education“ content on “Diabetes Mellitus“ (ICD9 code 250). In addition, the diabetic foot entry is tagged with a category element that conveys “Diabetes with peripheral circulatory disorders“ (ICD9 code 250.7).

The*entry.summary* elements provide a short snapshot of the available content for quick preview.

Knowledge request payload: KnowledgeRequestPayload_example1.xml
Knowledge response payload: KnowledgeResponsePayload_example1.xml

5.2 Example 2

Knowledge Request: A provider reviewing a problem list of a female, 67 years-old patient, with “bacterial pneumonia.“ The provider wishes to retrieve clinical knowledge content on the “treatment of bacterial pneumonia.“

Knowledge Response: A knowledge resource (PubMed) retrieves a knowledge response with three potentially relevant entries that represent article abstracts indexed in PubMed.

The overall language of the response is English (see *feed.xml:lang* attribute) since PubMed only supports English abstracts. Each entry contains the article abstract (*entry.summary* element), a *link* to the abstract in PubMed, and possibly an *alternativelink* to the full-text article. Since PubMed indexes English abstracts of full-text articles that are written in other languages, each alternative *entry.link* element has an *hreflang* attribute that specifies the language of the full-text article (e.g., entry #3 contains a link to a full-text article in Chinese).

The overall feed is tagged with a category element that conveys “treatment (MeSH code Q000628) of bacterial pneumonia (MeSH code D018410) in people 65 years old or above (Aged, MeSH code D000368)“. Each entry is also tagged with a category that indicates a more specific subject of the article in addition to bacterial pneumonia (e.g., Methicillin-Resistant Staphylococcus aureus).

Knowledge request payload: KnowledgeRequestPayload_example2.xml
Knowledge response payload: KnowledgeResponsePayload_example2.xml

5.3 Example 3 – Knowledge Resource DSS evaluate operation

The following examples illustrate instances of the DSS *evaluate* operation objects (*EvaluationRequest*and *EvaluationResponse*). The XML structure of these examples was automatically generated from the OMG DSS Minimum Functional Profile WSDL file, which is available elsewhere.[7]

EvaluationRequest: DSS_EvaluationRequest.xml
EvaluationResponse: DSS_EvaluationResponse.xml

6 References

1. Cimino JJ, Elhanan G, Zeng Q. Supporting infobuttons with terminological knowledge. Proc AMIA Annu Fall Symp. 1997:528-32.
2. Cimino JJ, Li J, Bakken S, Patel VL. Theoretical, empirical and practical approaches to resolving the unmet information needs of clinical information system users. Proc AMIA Symp. 2002:170-4.
3. HL7 Context-Aware Knowledge Retrieval ("Infobutton"), Knowledge RequestStandard. Health Level Seven International. May, 2010. Available at http://www.hl7.org/v3ballot2010may/html/domains/uvds/uvds_Context-awareKnowledgeRetrieval%28Infobutton%29.htm. Retrieved on July 12th, 2010.
4. HL7 Context-Aware Knowledge Retrieval ("Infobutton"), URL-Based Implementation Guide. Health Level Seven International. Sep, 2009. Available at http://www.hl7.org/v3ballot2010may/html/domains/uvds/Infobutton_IG.pdf. Retrieved on October26th, 2010.
5. HL7 Service Functional Model Specification – Decision Support Service (DSS). HL7 Draft Standard for Trial Use - Release 1. Health Level Seven. December 2006. Available at http://www.hl7.org/documentcenter/ballots/2006SEP/support/AUDIT_SDO_CDS_DSS_R1_D1_2006SEP_20070129061919.pdf. Retrieved on July 12th, 2010.
6. Clinical Decision Support Service Technical Specification. Version 1.0. Object Management Group. Available at http://hssp-dss.wikispaces.com/omg_specification. Retrieved on February 1st 2011.
7. Clinical Decision Support Service. Version 1.0. Machine Readable Files. Version 1.0. Object Management Group. Available at http://hssp-dss.wikispaces.com/omg_specification. Retrieved on February 1st 2011.
8. Web syndication. Wikipedia. Available athttp://en.wikipedia.org/wiki/Web_syndication.Retrieved on July 12th, 2010.
9. RSS 2.0 Specification. BerkmanCenter for Internet & Society at HarvardLawSchool. Available at http://cyber.law.harvard.edu/rss/rss.html. Retrieved on July 12th, 2010.
10. The Atom Syndication Format. Network Working Group. IETF. Available at http://www.ietf.org/rfc/rfc4287.txt. Retrieved on July12th, 2010.