

Meeting Minutes 11 April 2001

Serialization of BQS

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1 Introduction

These meeting minutes present an RDF serialization of the **DSL SRBibObjects** Module from the [OMG's Bibliographic Query Service Draft Specification](#)¹. This module presents an excellent general data model for bibliographic references. The CellML development team was impressed with this data model (henceforth referred to as the "BQS data model"), and wanted to use it to store references in CellML metadata. However, there was no RDF serialization for the data model, so Melanie set out to create one.

These meeting minutes are not formal documentation of the proposed serialization. This documentation will be provided elsewhere. However, the ideas and examples in these minutes will conform to the formal documentation.

The BQS data model draws extensively from the [Dublin Core metadata element set](#)². Therefore, the RDF serialization of these elements is used wherever possible. Elements specific to the BQS data model are placed in a BQS namespace with the value "<http://www.cellml.org/2001/03/bqs#>", and a recommended prefix of **bqs**. (The value of this namespace will probably be different when it appears in the CellML Metadata specification.)

Most of the remaining sections of these minutes go through the data structures defined in the [OMG's Bibliographic Query Service Draft Specification](#), indicating how these structures can be defined in RDF. Section 11 provides some complete examples of the use of this serialization.

The CellML Metadata specification will require CellML metadata processing software to correctly interpret the structures discussed in this document, unless otherwise noted. Model authors are free to include other metadata, including the non-required structures described in this document. However, CellML metadata compliant processors are free to ignore these non-required metadata elements.

2 The BibliographicReference Class

The **BibliographicReference** class is the root class for all reference information. It is represented in RDF by the `<bqs:reference>` element. This element creates a reference resource, and must therefore be given an `rdf:parseType` attribute value of "`Resource`". All further content of this element is providing metadata about the reference resource itself.

2.1 The identifier attribute

The **identifier** attribute on the **BibliographicReference** class was one of the attributes that first sold Melanie on using the BQS data model. This attribute provides an elegant way to identify a cited reference using a database identifier (such as a Medline UI) instead of by providing the complete reference details.

¹<http://www.omg.org/cgi-bin/doc?dtc/01-03-02>

²<http://dublincore.org/documents/dces/>

The BQS data model uses a structured string to store the identifier data. The first part of this string indicates the kind of identifier being used (i.e., “Medline”). The second part of the string provides the actual identifier (i.e., “9067300”). The two parts of the string are separated by a slash (“/”).

RDF does not allow us to enforce the structured string format of the identifier attribute. However, as Figure 1 shows, this data can still be serialized into RDF using the Dublin Core `<dc:identifier>` element. This element is qualified by an encoding scheme, which can store the “kind of identifier” information. The encoding scheme extension is analogous to the extension provided by the [Dublin Core qualifiers set](#)³, but this set does not include the necessary encoding schemes (the only encoding scheme currently supported is “URI”). Therefore, the `<identifier_scheme>` element is placed in the BQS namespace. The `<bqs:identifier_scheme>` element may take on any value. However, we recommend the use of the following:

- `Medline` for the identifier that is common to all implementations of the Medline database.
- `PubMed` for the identifier used only by the PubMed implementation of the Medline database.
- `CAS` for the identifier used by the Chemical Abstract Service database.

```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:identifier rdf:parseType="Resource">
        <bqs:identifier_scheme>Medline</bqs:identifier_scheme>
        <rdf:value>97219925</rdf:value>
      </dc:identifier>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>
```

FIGURE 1: Serialization of the **BibliographicReference** class’s **identifier** attribute.

2.2 The `cross_references` attribute

The `cross_references` attribute on the **BibliographicReference** class is intended to store alternative identifiers for the reference represented by the contents of the identifier attribute. This can be represented in RDF by further qualifying the `<dc:identifier>` element with information about the type of identifier. Identifiers that represent cross references should be given a `<bqs:identifier_type>` value of `alternative`, as shown in Figure 2.

2.3 The `type` attribute

The `type` attribute on the **BibliographicReference** class identifies the “genre” of the cited resource. The BQS data model provides constructs for the following types of references:

³<http://dublincore.org/documents/dcmes-qualifiers/>

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:identifier rdf:parseType="Resource">
        <bqs:identifier_scheme>Medline</bqs:identifier_scheme>
        <rdf:value>97219925</rdf:value>
      </dc:identifier>
      <dc:identifier rdf:parseType="Resource">
        <bqs:identifier_scheme>PubMed</bqs:identifier_scheme>
        <bqs:identifier_type>alternative</bqs:identifier_type>
        <rdf:value>9067300</rdf:value>
      </dc:identifier>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 2: The reference information in Figure 1 is extended to include a cross reference. This cross reference provides the PubMed identifier for the same reference.

- "Article" (subclassed into "JournalArticle", for journal articles, and "BookArticle", for book chapters).
- "Book"
- "Patent"
- "Proceeding"
- "TechReport" (note that this can be used for unpublished reports)
- "Thesis"
- "WebResource"

Note that it is possible to create additional types of references using the BQS data model. The basic information would be provided by the **BibliographicReference** class. Information specific to the new type of reference would need to be provided as a subclass by the person wishing to create the new reference type.

As Figure 3 shows, reference type metadata can be provided using a `<bqs:reference_type>` element. The reference type should be given by a URL stored in the `rdf:resource` attribute on the `<bqs:reference_type>` element. The `rdf:resource` attribute is used because the structure of the subclasses that represent the different types of references is defined in the RDF schema for the BQS serialization. The RDF resource that defines the structure of a particular reference type is uniquely identified by the value of the `rdf:resource` attribute.

2.4 The title attribute

The title attribute on the **BibliographicReference** class is used to store the title of the resource being referenced. For instance, if the referenced resource is a book chapter, the title metadata would be the title of the chapter.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#JournalArticle" />
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 3: Serialization of reference type information. See text for more info.

The title metadata can be serialized using the Dublin Core `<dc:title>` element, as shown in Figure 4. Note that an `xml:lang` attribute could be used to indicate the language of the title.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:title>
        Inhibition of cardiac potassium currents by the vesnarinone
        analog OPC-18790: comparison with quinidine and dofetilide
      </dc:title>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 4: Serialization of reference title information.

2.5 The rights attribute

The **rights** attribute on the **BibliographicReference** class provides information about the rights over the cited resource. This attribute would typically contain either a statement of the rights, or a reference to a resource (such as a web page) that states the rights. Rights information may include intellectual property rights and copyrights. No assumptions can be made about the rights on the resource in the absence of this attribute.

This rights attribute maps directly to the Dublin Core `<dc:rights>` element. The serialization is shown in Figure 5.

[Note: this particular aspect of the BQS data model will probably not be required by the CellML meta-data specification.]

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:rights>Physiome Sciences, 2001</dc:rights>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 5: Serialization of reference rights information. See text for more info.

2.6 The language attribute

The **language** attribute on the **BibliographicReference** class defines the language of the cited resource. The BQS data model recommends using the RFC1766 encoding scheme for this information.

Language metadata can be stored using the qualified Dublin Core **<dc:language>** element, as shown in Figure 6. The CellML Metadata specification will recommend use of **RFC1766** as a language scheme.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:language rdf:parseType="Resource">
        <dcq:languageScheme>RFC1766</dcq:languageScheme>
        <rdf:value>en-uk</rdf:value>
      </dc:language>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 6: Serialization of language information. This metadata indicates the content of the cited resource is written in United Kingdom English.

[Note: this particular aspect of the BQS data model will probably not be required by the CellML metadata specification.]

2.7 The format attribute

The **format** attribute on the **BibliographicReference** class describes the “physical or digital manifestation of the cited resource”. The value of this attribute will depend heavily on the reference type. For instance, a

web resource reference might have format values of `application/pdf` or `text/html`. This serialization of the BQS data model will not attempt to extend the values of this attribute beyond what is provided by the Dublin Core.

The format metadata is serialized using the qualified Dublin Core `<dc:format>` element. The Dublin Core recommends using the Internet Media Type (IMT) encoding scheme for formats, commonly called MIME types. A [list of these types](#)⁴ is provided by the Information Sciences Institute at the University of Southern California. Figure 7 demonstrates the RDF serialization of the Dublin Core format element.

```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:format rdf:parseType="Resource">
        <dcq:formatType>Medium</dcq:formatType>
        <dcq:formatScheme>IMT</dcq:formatScheme>
        <rdf:value>application/pdf</rdf:value>
      </dc:format>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>
```

FIGURE 7: Serialization of format information. This metadata indicates the content of the cited resource is in the PDF format.

[Note: this particular aspect of the BQS data model will probably not be required by the CellML metadata specification.]

2.8 The date attribute

The **date** attribute on the **BibliographicReference** class “defines a date associated with an event in the life cycle of the cited resource”. For public resources, this should be the publication date. For private resources (such as unpublished technical reports), this should be the creation date.

Date metadata can be stored in the qualified Dublin Core `<dc:date>` element, as shown in Figure 8. The use of the `<dcq:dateType>` and `<dcq:dateScheme>` elements is discussed further in the [26 March 2001](#)⁵ and [3 April 2001](#)⁶ meeting minutes.

2.9 The authors attribute

The **authors** attribute stores information about the authors of the cited reference. Its value is an instance of the **Provider** class. The serialization of this class is discussed in Section 3. If there is more than one author for the reference, the BQS data model requires that these authors be stored in an ordered list.

⁴<http://www.isi.edu/in-notes/iana/assignments/media-types/media-types>

⁵http://www.cellml.org/private/progress_reports/20010326_meeting_minutes.html

⁶http://www.cellml.org/private/progress_reports/20010403_meeting_minutes.html

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:date rdf:parseType="Resource">
        <dcq:dateType>issued</dcq:dateType>
        <dcq:dateScheme>W3C-DTF</dcq:dateScheme>
        <rdf:value>1997</rdf:value>
      </dc:date>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 8: Serialization of date information. This metadata indicates the cited resource was published in 1997 (note that the W3C-DTF encoding allows full dates, month/year dates, and year-only dates).

The **authors** attribute can be serialized using the Dublin Core **<dc:creator>** element. Multiple authors can be stored in an **<rdf:Seq>** container, which creates an ordered list.

Figure 9 demonstrates how to store author metadata. All of the authors are people.

2.10 The contributors attribute

The **contributors** class can be used to store information about a person or entity that contributed to, but did not create the reference. It can be serialized using the Dublin Core **<dc:contributor>** element, as shown in Figure 10. If there is more than one contributor, the **<rdf:Seq>** container can be used to create an ordered list, as was done for the **authors** class.

2.11 The publisher attribute

The **publisher** attribute stores information about the publisher of the reference. It can be serialized using the Dublin Core **<dc:publisher>** element, as shown in Figure 11. Only one publisher is allowed, so no RDF containers may be used in this element.

3 The Provider class

The **Provider** class is the base class for the **Person**, **Organization** and **Service** classes. These classes are used by the **authors**, **contributors** and **publisher** attributes on the **BibliographicReference** class. The BQS data model allows only one publisher, and requires that the authors and contributors be provided as an ordered list.

The **Provider** class is serialized by embedding the information directly in the RDF element that serializes the **authors**, **contributors**, **publisher**, or **editor** attribute. Multiple providers are supported using an **<rdf:Seq>** container. The subclass of provider is identified using a **<bqs:provider_type>** element to indicate which subclass of Provider is being used. The valid values are "Person", "Organisation",

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:creator>
        <rdf:Seq>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Yang</vCard:Family>
                <vCard:Given>T</vCard:Given>
              </vCard:N>
              <vCard:EMAIL rdf:parseType="Resource">
                <rdf:value>phoney@nowhere.com</rdf:value>
                <rdf:type rdf:resource="http://imc.org/vCard/3.0#internet" />
              </vCard:EMAIL>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Snyders</vCard:Family>
                <vCard:Given>D</vCard:Given>
                <vCard:Other>J</vCard:Other>
              </vCard:N>
              <vCard:ORG rdf:parseType="Resource">
                <vCard:Orgname>
                  Vanderbilt University School of Medicine
                </vCard:Orgname>
                <vCard:Orgunit>Department of Pharmacology</vCard:Orgunit>
              </vCard:ORG>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Roden</vCard:Family>
                <vCard:Given>D</vCard:Given>
                <vCard:Other>M</vCard:Other>
              </vCard:N>
              <vCard:ADR rdf:parseType="Resource">
                <vCard:Extadd>
                  Dept. of Pharmacology,
                  Vanderbilt University School of Medicine
                </vCard:Extadd>
                <vCard:Locality>Nashville</vCard:Locality>
                <vCard:Region>TN</vCard:Region>
                <vCard:Pcode>37232-6602</vCard:Pcode>
                <vCard:Country>USA</vCard:Country>
              </vCard:ADR>
            </rdf:value>
          </rdf:li>
        </rdf:Seq>
      </dc:creator>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 9: Serialization of author information. The `<rdf:Seq>` container creates an ordered list of authors. Information about the authors is stored using vCard. To save space in this example, the first author is given an e-mail address, the second author an affiliation, and the third author a postal address. For an actual reference, all authors could have all three types of information. Alternatively, only the authors' names might be available.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:contributor rdf:parseType="Resource">
        <bqs:provider_type
          rdf:resource="http://www.cellml.org/2001/03/bqs#Organization" />
        <rdf:value>Super Scientific Graphics, Inc.</rdf:value>
      </dc:contributor>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 10: Serialization of contributor information. An organization (in this example, a company) is listed. This company may have provided graphics work for the cited reference. In this example, there is only one contributor. However, an `<rdf:Seq>` container could be used to create an ordered list of contributors, as was done in the author example. If the contributors were people, information about them could be stored using vCard, as shown in the authors example.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:publisher rdf:parseType="Resource">
        <bqs:provider_type
          rdf:resource="http://www.cellml.org/2001/03/bqs#Service" />
        <rdf:value>my software service</rdf:value>
      </dc:publisher>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 11: Serialization of publisher information. A software service is the publisher of the reference in this example.

and "Service". The provider type should be given by a URL stored in the `rdf:resource` attribute on the `<bqs:provider_type>` element. The `rdf:resource` attribute is used because the structure of the subclasses that represent the different types of providers is defined in the RDF schema for the BQS serialization. The RDF resource that defines the structure of a particular provider type is uniquely identified by the value of the `rdf:resource` attribute. The actual identity of the provider (as defined by the relevant subclass) is enclosed in an `<rdf:value>` element.

In cases where all providers in a list are from the same subclass, an RDF distributive statement could be used to indicate that each member of the `<rdf:Seq>` container has a given type. This construct will not be discussed further in these meeting minutes, but will be considered, and a recommendation about its use will be made in the formal description of the RDF serialization of the BQS data model.

3.1 The Person subclass

Structured information about a person can be stored using the appropriate vCard constructs, as described in a W3C note about [Representing vCard Objects in RDF/XML](#)⁷. (This note is the work of Renato Iannella working at the Distributed Systems Technology Centre at the University of Queensland and originally appeared on their [RDF project page](#)⁸.) The BQS data model only requires a subset of vCard. The vCard elements for the attributes in the BQS Person class are:

- **surname** = `<vCard:Family>` element, as a child of the `<vCard:N>` element
- **first_name** = `<vCard:Given>` element, as a child of the `<vCard:N>` element
- **middle_initials** = `<vCard:Other>` element, as a child of the `<vCard:N>` element
- **email** = `<vCard:EMAIL>` element
- **postal_address** = `<vCard:ADR>` construct, which includes subelements for post office box, street address, locality (city), region (state), country, postal code, and an extended address field (for institute or company name).
- **affiliation** = `<vCard:ORG>` construct, which includes subelements for the organization name and the division/department.

Figure 9 shows an example of **Person** provider information for the **authors** attribute.

3.2 The Organisation and Service subclasses

The organization and service information is a name, stored as a string. This can be entered directly as the content of an RDF element. However, in some cases it is useful to provide the geographic location of the organization. For instance, this information is usually provided for the publisher of a book. This can be supported using the **Property** class, as discussed in Section 9. In this case, the name of the organization is stored in an `<rdf:value>` element contained in the `<dc:publisher>` element. Examples of the use of the **Organisation** and **Service** subclasses are shown in Figure 10 and Figure 11.

4 The BibRefSubject class

The **BibRefSubject** class defines the topic of the resource. It has three attributes, **keywords**, **subheadings** and **codes**, which provide a means to store keywords, subject headings, and classification codes about the cited resource, respectively.

⁷<http://www.w3.org/TR/2001/NOTE-vcard-rdf-20010222>

⁸<http://www.dstc.edu.au/Research/Projects/rdf/>

All three attributes in the **BibRefSubject** class can be handled by the Dublin Core `<dc:subject>` element. This element can be qualified with a `<bqs:subject_type>` element to indicate the type of subject and with a `<dcq:subjectScheme>` element to indicate the encoding scheme for the subject.

Multiple subjects can be stored using the appropriate RDF container (bag, sequence, or alternative). Keywords, subject headings, and classification codes may *not* be mixed in a single `<dc:subject>` element. This is consistent with the data model (which has the three types of subject information as three different attributes), and also simplifies the serialization. However, a single reference resource may have multiple `<dc:subject>` elements.

An example demonstrating the serialization of subject metadata is shown in Figure 12.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:subject rdf:parseType="Resource">
        <bqs:subject_type>subject_heading</bqs:subject_type>
        <dcq:subjectScheme>MESH</dcq:subjectScheme>
        <rdf:value>
          <rdf:Bag>
            <rdf:li>Signal Transduction</rdf:li>
            <rdf:li>Ion Transport</rdf:li>
          </rdf:Bag>
        </rdf:value>
      </dc:subject>
      <dc:subject rdf:parseType="Resource">
        <bqs:subject_type>classification_code</bqs:subject_type>
        <dcq:subjectScheme>DDC</dcq:subjectScheme>
        <rdf:value>572</rdf:value>
      </dc:subject>
      <dc:subject rdf:parseType="Resource">
        <bqs:subject_type>keyword</bqs:subject_type>
        <rdf:value>
          <rdf:Seq>
            <rdf:li>calcium signaling</rdf:li>
            <rdf:li>calcium import</rdf:li>
          </rdf:Seq>
        </rdf:value>
      </dc:subject>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 12: Serialization of subject information. The three types of subject information are shown. First, an unordered group of subject headings is provided, encoding in the MeSH controlled vocabulary. Next, the Dewey Decimal System classification code is provided. Finally, an ordered group of uncontrolled keywords is provided.

The formal mapping of the attributes in the **BibRefSubject** class to RDF is as follows:

- **keywords:** `<bqs:subject_type>` value of `keyword`, no `<dc:subjectScheme>` element.
- **subheadings:** `<bqs:subject_type>` value of `subject_heading`, `<dc:subjectScheme>` value of LCSH (Library of Congress Subject Headings) or MeSH (Medical Subject Headings).
- **codes:** `<bqs:subject_type>` value of `classification_code`, `<dc:subjectScheme>` value of DDC (Dewey Decimal Classification), LCC (Library of Congress Classification), or UDC (Universal Decimal Classification).

In all cases, multiple values should be stored in the appropriate RDF container.

[Note: this particular aspect of the BQS data model will probably not be required by the CellML metadata specification.]

5 The BibRefDescription class

The **BibRefDescription** class allows storage of a summary of the contents of the cited reference. This summary could be an abstract or a table of contents, and may be in a language different from that of the actual reference. More than one summary may be stored about a reference. The [BQS Draft Specification](#)⁹ states that the contents of the abstract and table of contents attributes may be more than just plain text, and proposes using MIME types to identify the format of these contents.

The **the_abstract** and **table_of_contents** attributes can be serialized using a `<dc:description>` element. This element can be qualified with type information to indicate whether the description is an abstract or a table of contents. This is done by adding a `<dcq:descriptionType>` element with a value of `abstract` or `tableOfContents`. This element and these qualifiers are taken from the Dublin Core Qualifiers specification. The **language** attribute can be indicated by an `xml:lang` attribute. Note that an `<rdf:Alt>` container can be used to provide the description in various languages.

The **abstract_type** and **toc_type** attributes can be serialized with the Dublin Core `<dc:format>` element. This element is qualified with an encoding scheme element, the value of which should be `IMT` (this indicates the use of a MIME type for the value of the format element). The full serialization of description metadata is shown in Figure 13.

If the abstract or table of contents is supplied by a URL, the URL should be entered as the value of the `<dc:description>` element, and the value of the enclosed `<dc:format>` element should be `text/url`. This is shown for the abstract information in Figure 13.

[Note: this particular aspect of the BQS data model will probably not be required by the CellML metadata specification.]

6 The BibRefScope class

The **BibRefScope** class is used to provide information about the intended scope or extent of the cited reference. It can include spatial location information and/or temporal period information in its **spatial_location** and **temporal_period** attributes.

This metadata can be mapped directly to the Dublin Core `<dc:coverage>` element, qualified to indicate whether the coverage is spatial or temporal, and to provide the encoding scheme of the content. The qualifiers `spatial` and `temporal` and a number of encoding schemes are defined in the Dublin Core Qualifiers specification. Two instances of this element can be used to include both spatial and temporal information.

Figure 14 shows the serialization of the scope metadata.

⁹<http://www.omg.org/cgi-bin/doc?dtc/01-03-02>

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:description rdf:parseType="Resource" xml:lang="en">
        <dcq:descriptionType>abstract</dcq:descriptionType>
        <dc:format rdf:parseType="Resource">
          <dcq:formatScheme>IMT</dcq:formatScheme>
          <rdf:value>text/url</rdf:value>
        </dc:format>
        <rdf:value>
          http://www.abstractsRus.com/abstract567843
        </rdf:value>
      </dc:description>
      <dc:description rdf:parseType="Resource" xml:lang="en">
        <dcq:descriptionType>tableOfContents</dcq:descriptionType>
        <dc:format rdf:parseType="Resource">
          <dcq:formatScheme>IMT</dcq:formatScheme>
          <rdf:value>text/html</rdf:value>
        </dc:format>
        <rdf:value rdf:parseType="Literal">
          <p> ... table of contents info here ...</p>
        </rdf:value>
      </dc:description>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 13: Serialization of description information. In this example, the abstract is provided as a URL, and the table of contents is provided inline, in HTML.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:scope rdf:parseType="Resource">
        <dcq:scopeType>temporal</dcq:scopeType>
        <dcq:scopeScheme>W3C-DTF</dcq:scopeScheme>
        <rdf:value>1997</rdf:value>
      </dc:scope>
      <dc:scope rdf:parseType="Resource">
        <dcq:scopeType>spatial</dcq:scopeType>
        <dcq:scopeScheme>ISO3166</dcq:scopeScheme>
        <rdf:value>BS</rdf:value>
      </dc:scope>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 14: Serialization of scope information. This metadata indicates the cited resource has a temporal scope of one year (1997) and a spatial scope of a single country (the Bahamas).

[Note: this particular aspect of the BQS data model will probably not be required by the CellML meta-data specification.]

7 The EntryStatus class

The **EntryStatus** class provides information about the citation, as opposed to the cited reference. It has three attributes. The **last_modified_date** attribute defines the date on which the citation was last changed. The **subset** attribute defines the subset of the bibliographic repository from which the current citation was taken. The **properties** attribute is a member of the Property class, and takes the form property name: property value, and can be used to supply general properties about the citation. For instance, it could be used to provide a version number for the citation. The Property class will be dealt in Section 9.

This metadata is about the citation, and not the reference. Therefore, it must be contained in a new RDF resource. We'll call the element that will be used to create this resource **<bqs:entry_status>**, to remain consistent with the class name. This resource can have three types of metadata:

- A last modified date, stored in a qualified Dublin Core **<dc:date>** element, as shown in Figure 15
- A subset, stored in a **<bqs:subset>** element, as shown in Figure 15
- A property, stored as defined in Section 9

[Note: this particular aspect of the BQS data model will probably not be required by the CellML meta-data specification.]

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:entry_status rdf:parseType="Resource">
        <dc:date rdf:parseType="Resource">
          <dcq:dateType>modified</dcq:dateType>
          <dcq:dateScheme>W3C-DTF</dcq:dateScheme>
          <rdf:value>2001-04-06</rdf:value>
        </dc:date>
        <bqs:subset>312-A</bqs:subset>
      </bqs:entry_status>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 15: Serialization of entry status information. The last modified date is stored using standard Dublin Core elements. The subset information is stored in a BQS-specific element. The subset in this example is completely fictitious.

8 The Journal class

The **Journal** class stores information about journals, and is referenced by the **JournalArticle**, a subclass of the **BibliographicReference** class. The **Journal** class has three attributes: **issn** (the International Standard Serial Number for the journal), **name** (the full name of the journal), and **abbreviation** (an abbreviation for the journal).

There are two possible uses for this class. One is to create a list of journals, which can be referenced by citations of type "**JournalArticle**". The other is to actually indicate the journal for a particular bibliographic reference. The same serialization can be used in both cases. In the latter case, it is likely that only the name or abbreviation of the journal would be provided.

Journal information is stored in a **<bqs:journal>** element. The attributes of the **Journal** class are serialized with the Dublin Core **<dc:title>** element for the name of the journal, a **<bqs:issn>** element for the ISSN, and a **<bqs:abbreviation>** element for the abbreviation.

A **<dc:identifier>** could be used to store the ISSN. However, this could lead to confusion with the use of the **<dc:identifier>** element to store a database UI (the **identifier** and **cross_references** attributes on the **BibliographicReference** class). Therefore, in this serialization of the BQS data model, the **<dc:identifier>** element is used to store the identifier of the *citation*, not the identifier of the cited *resource*. A new **<bqs:issn>** element is created to store the identifier of the journal resource.

The **<bqs:abbreviation>** element is qualified by a **<bqs:abbreviation_scheme>** element. This is necessary because there is not a single list of standard journal abbreviations. This element may take on any value. However, we recommend the use of the following:

- **Medline**: Most biological and medical journals are indexed by Medline, which provides a [downloadable list of its journals](http://www.ncbi.nlm.nih.gov/entrez/getids.help.htm#JournalLists)¹⁰.

¹⁰<http://www.ncbi.nlm.nih.gov/entrez/getids.help.htm#JournalLists>

- **CAS**: The Chemical Abstract Service abstracts chemical journals.

Use of the `<bqs:abbreviation>` element without a `<bqs:abbreviation_scheme>` element can be inferred to mean that the abbreviation is not necessarily taken from a standard list. In this case, the full name of the journal or the ISSN should also be provided.

Figure 16 demonstrates the definition of information about a journal. Note that this example is **not** part of a `<bqs:reference>` resource. This means that the journal is being defined as its own resource. By giving the `<rdf:Description>` element that contains the `<bqs:journal>` element an `id` attribute, we allow other resources to refer to this one. For instance, we could create a collection of journals, and refer to a journal in this collection in a reference of type "JournalArticle" using the value of the `id` attribute of the journal.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"

  <rdf:Description id="journal1">
    <bqs:journal rdf:parseType="Resource">
      <dc:title>Journal of Biological Chemistry</dc:title>
      <bqs:issn>0021-9258</bqs:issn>
      <bqs:abbreviation rdf:parseType="Resource">
        <bqs:abbreviation_scheme>Medline</bqs:abbreviation_scheme>
        <rdf:value>J Biol Chem</rdf:value>
      </bqs:abbreviation>
    </bqs:journal>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 16: Serialization of journal information. This example shows how to create a new journal resource, to which other RDF resources may refer.

Examples in Section 10.2 will demonstrate possible methods for referring to journals in journal article references.

9 The Property class

The **Property** class can be referenced by the **BibliographicReference**, **Journal**, **Provider**, **BibRefScope**, and **EntryStatus** classes to add properties to the data model. The **Property** class provides a general way to extend the data model. Note that the data model can also be extended by creating new RDF elements in a non-BQS namespace.

The **Property** class can be serialized with a qualified `<bqs:property>` attribute, as follows:

- `property_name` = `<bqs:property_type>`
- `property_value` = `<rdf:value>`

If format information is required, a Dublin Core `<dc:format>` element is used, as described for the **BibRefDescription** class.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:property rdf:parseType="Resource">
        <bqs:property_type>online</bqs:property_type>
        <rdf:value>yes</rdf:value>
      </bqs:property>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 17: Serialization of property information. In this example, a new property called “online” is introduced. This property indicates whether or not the full text of the article is available online.

Figure 17 shows the serialization of the **Property** class.

Figure 18 shows the use of a **<bqs:property>** element to store the location of a publisher. This information is commonly provided when referencing a book.

10 Subclasses of the BibliographicReference Class

The BQS data model provides seven basic subclasses of the **BibliographicReference** class, one of which is further subclassed. In addition, users can create their own type of **BibliographicReference**. To do this in the RDF serialization, the user would supply a new value for the **type** attribute on the **BibliographicReference** class, and provide any additional information either by using the **Property** class (discussed in Section 9) or by defining his/her own RDF schema for that reference type.

The **Thesis**, **Proceeding**, and **TechReport** subclasses do not define any additional attributes. The other subclasses are discussed in the following subsections.

10.1 The Book subclass

The **Book** subclass has five attributes, which are mapped onto BQS elements as follows:

- **isbn** (the International Standard Book Number) = **<bqs:isbn>** (Note that a **<dc:identifier>** element could be used to store the ISBN. However, this could lead to confusion with the use of the **<dc:identifier>** element to store a database UI (the **identifier** and **cross_references** attributes on the **BibliographicReference** class). Therefore, in this serialization of the BQS data model, the **<dc:identifier>** element is used to store the identifier of the *citation*, not the identifier of the cited *resource*. A new **<bqs:isbn>** element is created to store the identifier of the book resource.)
- **volume** = **<bqs:volume>** (note: this element is also used in the serialization of the **JournalArticle** subclass)
- **edition** = **<bqs:edition>**
- **series** (the title of the series of which the book is a member) = **<bqs:series>**

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:publisher rdf:parseType="Resource">
        <bqs:provider_type
          rdf:resource="http://www.cellml.org/2001/03/bqs#Organisation" />
        <rdf:value>O'Reilly and Associates, Inc.</rdf:value>
        <bqs:property rdf:parseType="Resource">
          <bqs:property_type>location</bqs:property_type>
          <rdf:value>Sebastopol, CA</rdf:value>
        </bqs:property>
      </dc:publisher>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 18: The use of a property to provide the location of a publisher.

- **editor** = `<dc:contributor>`, qualified by `<bqs:contributor_type>` with a value of `editor`. Personal information about the editor (name, e-mail, etc.) is provided by the serialization of the **Provider** class (see Section 3).

Figure 19 demonstrates the storage of book information. Note that a real reference to a book would also include elements from the **BibliographicReference** class. Section 11 has several complete reference examples that demonstrate the use of information from the various BQS data model classes.

10.2 The Article subclass and its subclasses

The **Article** class has two attributes: **first_page** and **last_page**. In addition, it has two further subclasses: **JournalArticle**, which has **volume**, **issue**, **issue_supplement** and **from_journal** attributes, and **BookArticle**, which has a **from_book** attribute.

The attributes on the **Article**, **JournalArticle** and **BookArticle** classes can be serialized using the same elements:

- **first_page** = `<bqs:first_page>`.
- **last_page** = `<bqs:last_page>`.
- **volume** = `<bqs:volume>` (note that this element is also used in the serialization of the **Book** subclass).
- **issue** = `<bqs:issue>`.
- **issue_supplement** = `<bqs:issue_supplement>`.
- **from_journal** = `<bqs:journal>`, as described in Section 8.
- **from_book** = `<bqs:reference>`, where that reference is of type `"Book"`.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#Book" />
      <bqs:isbn>9-999-99999-X</bqs:isbn>
      <bqs:volume>5</bqs:volume>
      <bqs:edition>2nd</bqs:edition>
      <dc:contributor rdf:parseType="Resource">
        <bqs:contributor_type>editor</bqs:contributor_type>
        <rdf:value>
          <rdf:Seq>
            <rdf:li rdf:parseType="Resource">
              <bqs:provider_type
                rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
              <rdf:value rdf:parseType="Resource">
                <vCard:N rdf:parseType="Resource">
                  <vCard:Family>Doe</vCard:Family>
                  <vCard:Given>John</vCard:Given>
                </vCard:N>
              </rdf:value>
            </rdf:li>
            <rdf:li rdf:parseType="Resource">
              <bqs:provider_type
                rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
              <rdf:value rdf:parseType="Resource">
                <vCard:N rdf:parseType="Resource">
                  <vCard:Family>Smith</vCard:Family>
                  <vCard:Given>Suzy</vCard:Given>
                </vCard:N>
              </rdf:value>
            </rdf:li>
          </rdf:Seq>
        </rdf:value>
      </dc:contributor>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 19: Serialization of book information. This example is fictitious.

Figure 20 shows the definition of journal article metadata. In this example, the journal information is included inline. Figure 21 shows the definition of journal article metadata. In this example, the journal information is included by reference to another resource (such as a journal definition as shown in Figure 16). Figure 22 shows the definition of book chapter metadata. Note that these examples only show the metadata specific for these subclasses of `BibliographicReference`. Section 11 will provide several examples of complete citations.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#JournalArticle" />
      <bqs:first_page>56</bqs:first_page>
      <bqs:last_page>62</bqs:last_page>
      <bqs:volume>356</bqs:volume>
      <bqs:issue>6</bqs:issue>
      <bqs:issue_supplement>A</bqs:issue_supplement>
      <bqs:journal rdf:parseType="Resource">
        <dc:title>Journal of Biological Chemistry</dc:title>
        <bqs:abbreviation rdf:parseType="Resource">
          <bqs:abbreviation_scheme>Medline</bqs:abbreviation_scheme>
          <rdf:value>J Biol Chem</rdf:value>
        </bqs:abbreviation>
      </bqs:journal>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 20: Serialization of journal article information. In this example, the journal information is provided inline.

10.3 The Patent subclass

Serialization of this subclass is postponed pending further information.

10.4 The WebResource subclass

The `WebResource` subclass has three attributes, which can be serialized as follows:

- `url` = `<bqs:url>` (Note that a `<dc:identifier>` element could be used to store this information. However, this could lead to confusion with the use of the `<dc:identifier>` element to store a database UI (the `identifier` and `cross_references` attributes on the `BibliographicReference` class). Therefore, in this serialization of the BQS data model, the `<dc:identifier>` element is

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#JournalArticle" />
      <bqs:first_page>56</bqs:first_page>
      <bqs:last_page>62</bqs:last_page>
      <bqs:volume>356</bqs:volume>
      <bqs:issue>6</bqs:issue>
      <bqs:issue_supplement>A</bqs:issue_supplement>
      <bqs:journal rdf:resource="#journal1" />
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 21: Serialization of journal article information. In this example, the journal information is provided by referring to the resource created in Figure 16.

used to store the identifier of the *citation*, not the identifier of the cited *resource*. A new `<bqs:url>` element is created to store the identifier of the web resource.).

- **estimated_size** = `<bqs:estimated_size>`. The units of the estimated size can be stored in `<bqs:property>` element (see Section 9 for more information on this element).
- **cost** = `<bqs:cost>`. The units of the cost can be stored in `<bqs:property>` element (see Section 9 for more information on this element).

Figure 23 shows the definition of information about a web resource.

11 Complete Examples

This section provides several complete citation examples.

11.1 Journal Article with Inline Journal Definition

Figure 24 demonstrates the definition of a reference to a journal article, with the journal information included inline. The cited reference is:

Jafri, M.S., Rice, J.J., Winslow, R.L. “Cardiac Ca²⁺ dynamics: the role of ryanodine receptor adaptation and sarcoplasmic reticulum load” (1998) *Biophys J* **74**: 1149-1168.

11.2 Journal Article with a Reference to a Journal Definition

Figure 25 demonstrates the definition of a reference to a journal article, with the journal information included by reference to a resource defined elsewhere. Figure 26 demonstrates the definition of the journal

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#BookArticle" />
      <bqs:first_page>56</bqs:first_page>
      <bqs:last_page>62</bqs:last_page>
      <bqs:reference rdf:parseType="Resource">
        <bqs:reference_type
          rdf:resource="http://www.cellml.org/2001/03/bqs#Book" />
        <bqs:isbn>9-999-99999-X</bqs:isbn>
        <bqs:volume>5</bqs:volume>
        <bqs:edition>2nd</bqs:edition>
        <dc:contributor rdf:parseType="Resource">
          <bqs:contributor_type>editor</bqs:contributor_type>
          <rdf:value>
            <rdf:Seq>
              <rdf:li rdf:parseType="Resource">
                <bqs:provider_type
                  rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
                <rdf:value rdf:parseType="Resource">
                  <vCard:N rdf:parseType="Resource">
                    <vCard:Family>Doe</vCard:Family>
                    <vCard:Given>John</vCard:Given>
                  </vCard:N>
                </rdf:value>
              </rdf:li>
              <rdf:li rdf:parseType="Resource">
                <bqs:provider_type
                  rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
                <rdf:value rdf:parseType="Resource">
                  <vCard:N rdf:parseType="Resource">
                    <vCard:Family>Smith</vCard:Family>
                    <vCard:Given>Suzy</vCard:Given>
                  </vCard:N>
                </rdf:value>
              </rdf:li>
            </rdf:Seq>
          </rdf:value>
        </dc:contributor>
      </bqs:reference>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 22: Serialization of book article information. This example is a chapter from the book shown in Figure 19. The second **<bqs:reference>** element in this example stores information about the book.

```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#WebResource" />
      <bqs:url>http://www.some_website.com/</bqs:url>
      <bqs:estimated_size rdf:parseType="Resource">
        <rdf:value>100</rdf:value>
      <bqs:property rdf:parseType="Resource">
        <bqs:property_type>units</bqs:property_type>
        <rdf:value>kilobytes</rdf:value>
      </bqs:property>
    </bqs:estimated_size>
    <bqs:cost rdf:parseType="Resource">
      <rdf:value>100</rdf:value>
      <bqs:property rdf:parseType="Resource">
        <bqs:property_type>units</bqs:property_type>
        <rdf:value>kilobytes</rdf:value>
      </bqs:property>
    </bqs:cost>
  </bqs:reference>
</rdf:Description>
</rdf:RDF>
```

FIGURE 23: Serialization of web resource information.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#JournalArticle" />
      <dc:creator>
        <rdf:Seq>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Jafri</vCard:Family>
                <vCard:Given>M</vCard:Given>
                <vCard:Other>S</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Rice</vCard:Family>
                <vCard:Given>J</vCard:Given>
                <vCard:Other>J</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Winslow</vCard:Family>
                <vCard:Given>R</vCard:Given>
                <vCard:Other>L</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
        </rdf:Seq>
      </dc:creator>
      <dc:title>
        Cardiac Ca2+ dynamics: the role of ryanodine receptor
        adaptation and sarcoplasmic reticulum load
      </dc:title>
      <dc:date rdf:parseType="Resource">
        <dcq:dateType>issued</dcq:dateType>
        <dcq:dateScheme>W3C-DTF</dcq:dateScheme>
        <rdf:value>1998</rdf:value>
      </dc:date>
      <bqs:journal rdf:parseType="Resource">
        <dc:title>Biophysical Journal</dc:title>
        <bqs:abbreviation rdf:parseType="Resource">
          <bqs:abbreviation_scheme>Medline</bqs:abbreviation_scheme>
          <rdf:value>Biophys J</rdf:value>
        </bqs:abbreviation>
      </bqs:journal>
      <bqs:volume>74</bqs:volume>
      <bqs:first_page>1149</bqs:first_page>
      <bqs:last_page>1168</bqs:last_page>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 24: A complete journal article reference. Information about the journal itself is embedded within the reference.

information. The cited reference is the same as that in Section 11.1.

11.3 Citation by Unique Identifier

Figure 27 demonstrates the citation of a reference using a database unique identifier. In this example, a Medline unique identifier is used. An abstract is also included, by reference to a URL.

11.4 Complete Book

Figure 28 shows a relatively simple complete book reference. The cited reference is:

Branden, C., Tooze, J. "Introduction to Protein Structure" (1991) Garland Publishing, Inc., New York.

Figure 29 shows a more complicated reference to a book. The cited reference is:

Brody, J.S., Center, D.M., Tkachuk, V.A., Eds. "Signal Transduction in Lung Cells" (1993) *Lung Biology in Health and Disease*, 65. Marcel Dekker, Inc. New York.

11.5 Book Chapter

Figure 30 shows a complete book chapter reference. The cited reference is:

Rogers, M.S., Strehler, E.E. "Calmodulin-like proteins" in *Guidebook to the Calcium-Binding Proteins*, Celio, M.R., Pauls, T., Schwaller, B., eds. (1996) Oxford University Press, Oxford. pp. 41-43.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#JournalArticle" />
      <dc:creator>
        <rdf:Seq>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Jafri</vCard:Family>
                <vCard:Given>M</vCard:Given>
                <vCard:Other>S</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Rice</vCard:Family>
                <vCard:Given>J</vCard:Given>
                <vCard:Other>J</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Winslow</vCard:Family>
                <vCard:Given>R</vCard:Given>
                <vCard:Other>L</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
        </rdf:Seq>
      </dc:creator>
      <dc:title>
        Cardiac Ca2+ dynamics: the role of ryanodine receptor
        adaptation and sarcoplasmic reticulum load
      </dc:title>
      <dc:date rdf:parseType="Resource">
        <dcq:dateType>issued</dcq:dateType>
        <dcq:dateScheme>W3C-DTF</dcq:dateScheme>
        <rdf:value>1998</rdf:value>
      </dc:date>
      <bqs:journal
        rdf:resource="http://www.example.org/journals#BiophysJ" />
      <bqs:volume>74</bqs:volume>
      <bqs:first_page>1149</bqs:first_page>
      <bqs:last_page>1168</bqs:last_page>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 25: A complete journal article reference that refers to a different resource for information about the journal. The definition of the journal information is shown in Figure 26.

```
<!--
  This RDF is part of the file http://www.example.org/journals
-->
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description id="BiophysJ">
    <bqs:journal rdf:parseType="Resource">
      <dc:title>Biophysical Journal</dc:title>
      <bqs:abbreviation rdf:parseType="Resource">
        <bqs:abbreviation_scheme>Medline</bqs:abbreviation_scheme>
        <rdf:value>Biophys J</rdf:value>
      </bqs:abbreviation>
      <bqs:issn>0006-3495</bqs:issn>
    </bqs:journal>
  </rdf:Description>

  <rdf:Description id="JBiolChem">
    <bqs:journal rdf:parseType="Resource">
      <dc:title>Journal of Biological Chemistry</dc:title>
      <bqs:abbreviation rdf:parseType="Resource">
        <bqs:abbreviation_scheme>Medline</bqs:abbreviation_scheme>
        <rdf:value>J Biol Chem</rdf:value>
      </bqs:abbreviation>
      <bqs:issn>0021-9258</bqs:issn>
    </bqs:journal>
  </rdf:Description>

</rdf:RDF>
```

FIGURE 26: Information about two journals. This information could be referenced by bibliographic citations defined in the **<bqs:reference>** element.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <dc:identifier rdf:parseType="Resource">
        <bqs:identifier_scheme>Medline</bqs:identifier_scheme>
        <rdf:value>97219925</rdf:value>
      </dc:identifier>
      <dc:description rdf:parseType="Resource" xml:lang="en">
        <dcq:descriptionType>abstract</dcq:descriptionType>
        <dc:format rdf:parseType="Resource">
          <dcq:formatScheme>IMT</dcq:formatScheme>
          <rdf:value>text/url</rdf:value>
        </dc:format>
        <!--
          Note that the URI below, would not normally be split over two lines.
          It has been split so that it fits on a page
        -->
        <rdf:value>
          http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?
            cmd=Retrieve&db=PubMed&list_uids=9067300&dopt=Abstract
        </rdf:value>
      </dc:description>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 27: Citation by Medline unique identifier and inclusion of a reference to an abstract.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#Book" />
      <dc:creator>
        <rdf:Seq>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Branden</vCard:Family>
                <vCard:Given>Carl</vCard:Given>
              </vCard:N>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Tooze</vCard:Family>
                <vCard:Given>John</vCard:Given>
              </vCard:N>
            </rdf:value>
          </rdf:li>
        </rdf:Seq>
      </dc:creator>
      <dc:title>Introduction to Protein Structure</dc:title>
      <dc:date rdf:parseType="Resource">
        <dcq:dateType>issued</dcq:dateType>
        <dcq:dateScheme>W3C-DTF</dcq:dateScheme>
        <rdf:value>1991</rdf:value>
      </dc:date>
      <dc:publisher rdf:parseType="Resource">
        <bqs:provider_type
          rdf:resource="http://www.cellml.org/2001/03/bqs#Organisation" />
        <rdf:value>Garland Publishing, Inc.</rdf:value>
        <bqs:property rdf:parseType="Resource">
          <bqs:property_type>location</bqs:property_type>
          <rdf:value>New York</rdf:value>
        </bqs:property>
      </dc:publisher>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 28: A complete book reference. Note the use of the **Property** class to provide the location of the publisher.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">

  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#Book" />
      <dc:contributor rdf:parseType="Resource">
        <bqs:contributor_type>editor</bqs:contributor_type>
        <rdf:value>
          <rdf:Seq>
            <rdf:li rdf:parseType="Resource">
              <bqs:provider_type
                rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
              <rdf:value rdf:parseType="Resource">
                <vCard:N rdf:parseType="Resource">
                  <vCard:Family>Brody</vCard:Family>
                  <vCard:Given>Jerome</vCard:Given>
                  <vCard:Other>S</vCard:Other>
                </vCard:N>
              </rdf:value>
            </rdf:li>
            <rdf:li rdf:parseType="Resource">
              <bqs:provider_type
                rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
              <rdf:value rdf:parseType="Resource">
                <vCard:N rdf:parseType="Resource">
                  <vCard:Family>Center</vCard:Family>
                  <vCard:Given>David</vCard:Given>
                  <vCard:Other>M</vCard:Other>
                </vCard:N>
              </rdf:value>
            </rdf:li>
            <rdf:li rdf:parseType="Resource">
              <bqs:provider_type
                rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
              <rdf:value rdf:parseType="Resource">
                <vCard:N rdf:parseType="Resource">
                  <vCard:Family>Tkachuk</vCard:Family>
                  <vCard:Given>Vsevolod</vCard:Given>
                  <vCard:Other>A</vCard:Other>
                </vCard:N>
              </rdf:value>
            </rdf:li>
          </rdf:Seq>
        </rdf:value>
      </dc:contributor>
      <dc:title>Signal Transduction in Lung Cells</dc:title>
      <dc:date rdf:parseType="Resource">
        <dcq:dateType>issued</dcq:dateType>
        <dcq:dateScheme>W3C-DTF</dcq:dateScheme>
        <rdf:value>1993</rdf:value>
      </dc:date>
      <bqs:series>Lung Biology in Health and Disease</bqs:series>
      <bqs:volume>65</bqs:volume>
      <dc:publisher rdf:parseType="Resource">
        <bqs:provider_type
          rdf:resource="http://www.cellml.org/2001/03/bqs#Organisation" />
        <rdf:value>Marcel Dekker, Inc.</rdf:value>
        <bqs:property rdf:parseType="Resource">
          <bqs:property_type>location</bqs:property_type>
          <rdf:value>New York</rdf:value>
        </bqs:property>
      </dc:publisher>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 29: A more complicated complete book reference.

```

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:bqs="http://www.cellml.org/2001/03/bqs#"
  xmlns:dc="http://purl.org/dc/elements/1.0/"
  xmlns:dcq="http://purl.org/dc/qualifiers/1.0/"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#"
  <rdf:Description about="#cellml_element_id">
    <bqs:reference rdf:parseType="Resource">
      <bqs:reference_type
        rdf:resource="http://www.cellml.org/2001/03/bqs#BookArticle" />
      <dc:creator>
        <rdf:Seq>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Rogers</vCard:Family>
                <vCard:Given>Michael</vCard:Given>
                <vCard:Other>S</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
          <rdf:li rdf:parseType="Resource">
            <bqs:provider_type
              rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
            <rdf:value rdf:parseType="Resource">
              <vCard:N rdf:parseType="Resource">
                <vCard:Family>Strehler</vCard:Family>
                <vCard:Given>Emanuel</vCard:Given>
                <vCard:Other>E</vCard:Other>
              </vCard:N>
            </rdf:value>
          </rdf:li>
        </rdf:Seq>
      </dc:creator>
      <bqs:first_page>41</bqs:first_page>
      <bqs:last_page>43</bqs:last_page>
      <dc:date rdf:parseType="Resource">
        <dcq:dateType>issued</dcq:dateType>
        <dcq:dateScheme>W3C-DTF</dcq:dateScheme>
        <rdf:value>1996</rdf:value>
      </dc:date>
      <bqs:reference rdf:parseType="Resource">
        <bqs:reference_type
          rdf:resource="http://www.cellml.org/2001/03/bqs#Book" />
        <dc:title>Guidebook to the Calcium-Binding Proteins</dc:title>
        <dc:contributor rdf:parseType="Resource">
          <bqs:contributor_type>editor</bqs:contributor_type>
          <rdf:value>
            <rdf:Seq>
              <rdf:li rdf:parseType="Resource">
                <bqs:provider_type
                  rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
                <rdf:value rdf:parseType="Resource">
                  <vCard:N rdf:parseType="Resource">
                    <vCard:Family>Celio</vCard:Family>
                    <vCard:Given>Marco</vCard:Given>
                    <vCard:Other>R</vCard:Other>
                  </vCard:N>
                </rdf:value>
              </rdf:li>
              <rdf:li rdf:parseType="Resource">
                <bqs:provider_type
                  rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
                <rdf:value rdf:parseType="Resource">
                  <vCard:N rdf:parseType="Resource">
                    <vCard:Family>Pauls</vCard:Family>
                    <vCard:Given>Thomas</vCard:Given>
                  </vCard:N>
                </rdf:value>
              </rdf:li>
              <rdf:li rdf:parseType="Resource">
                <bqs:provider_type
                  rdf:resource="http://www.cellml.org/2001/03/bqs#Person" />
                <rdf:value rdf:parseType="Resource">
                  <vCard:N rdf:parseType="Resource">
                    <vCard:Family>Schwaller</vCard:Family>
                    <vCard:Given>Beat</vCard:Given>
                  </vCard:N>
                </rdf:value>
              </rdf:li>
            </rdf:Seq>
          </rdf:value>
        </dc:contributor>
        <dc:publisher rdf:parseType="Resource">
          <bqs:provider_type
            rdf:resource="http://www.cellml.org/2001/03/bqs#Organisation" />
          <rdf:value>Oxford University Press</rdf:value>
          <bqs:property rdf:parseType="Resource">
            <bqs:property_type>location</bqs:property_type>
            <rdf:value>Oxford</rdf:value>
          </bqs:property>
        </dc:publisher>
      </bqs:reference>
    </bqs:reference>
  </rdf:Description>
</rdf:RDF>

```

FIGURE 30: A book chapter reference. (Some whitespace has been removed in order to fit the example on a single page.)