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Using the OpenURL Framework to Locate Bibliographic Resources

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Abstract

*OpenURLs are already in use in digital library information services providing links between resources that are appropriate to the context of the end-user. The OpenURL Framework for Context-Sensitive Services, a systematic generalisation of the existing de facto standard OpenURL, is currently an ANSI/NISO 'draft standard for trial use'. The **zetoc** current awareness service has implemented OpenURL links enabling its users to access services pertinent to discovered article records, including their full text. The 'ContextObject' of the OpenURL Framework supplies a standard way of encoding the bibliographic citation information for a scholarly resource within a Dublin Core metadata record.*

Keywords: *OpenURL, Dublin Core metadata, bibliographic citation, context-sensitive links, current awareness service.*

1. Introduction

Researchers wishing to keep abreast of current developments in their field use digital library applications to find articles of relevance. They may use for example 'abstracting and indexing' services, citation databases or electronic journal aggregation services. In the past when they found a reference to an article of interest they had to locate a print copy of the journal issue by visiting a library. In an increasingly networked world, researchers now prefer to locate articles electronically.

These expectations mean that digital library services need standard ways to record metadata properties of scholarly resources such as journal articles. This metadata has to include the bibliographic citation information for the resource, which for a journal article will detail the containing journal issue and identification within that issue such as a page number. Additionally information services need the ability to create appropriate links, customised for the user, to referenced resources.

The OpenURL Framework [1], a proposed NISO [2] standard, supplies a method to encode a context-sensitive link to a referenced work. This paper describes a practical application of OpenURL within a digital library service.

The paper also discusses using the OpenURL Framework to provide a suitable standard way to record the bibliographic citation information for a scholarly information resource within its own Dublin Core [3] metadata record. This is an orthogonal, 'non-linking' use of OpenURL.

2. Discovering Articles in *zetoc*

The ***zetoc*** [4] current awareness service provides access to the British Library's [5] Electronic Table of Contents of journal articles and conference papers. It is available to researchers, teachers and learners in UK Higher and Further Education under the BL/HEFCE 'strategic alliance' [6], and to practitioners within the National Health Service in England and Scotland. The ***zetoc*** database, updated daily, contains details of articles from approximately 20,000 current journals and 16,000 conference proceedings published per year. With over 20 million article and conference paper records from 1993 to date, the database covers every imaginable subject in science, technology, medicine, business, law, finance and the humanities.

Searches for articles in ***zetoc*** through its World Wide Web interface, return bibliographic citation details of the articles discovered. ***zetoc*** provides an alerting service through which users may request email 'table of contents' alerts to be sent to them when issues of their chosen journals are loaded into ***zetoc***. In addition users may set up alerts based on pre-defined search criteria in article titles or authors' names. These saved searches are performed on new data when it is loaded into ***zetoc*** each night, users being emailed with records of the articles that matched. Both types of alert contain listings of article details and include a URL enabling the user to go straight to the full record of a chosen article within the ***zetoc*** Web interface.

An obvious enhancement to the ***zetoc*** Web service was to provide access to the full text of discovered articles when it is available electronically. Failing the full text, or in addition, it would be helpful to users to provide article abstracts, which are not currently available in ***zetoc***, indications of where a printed copy of the journal could be found, and possibly further relevant information such as other articles by the same author. An evaluation study of ***zetoc*** asked users to complete an online questionnaire about their use of the service and desired enhancements [7]. This was an initial phase in a more comprehensive study. The most significant wish from users was the ability to access the full text of a discovered article directly from its ***zetoc*** record.

The problem of providing a link to the full text of an article is two-fold if the user is not to be given a link that may be a dead end. Firstly the bibliographic citation information must be translated into a URL that will link to an article. The encoding of such URL links is generally proprietary and not consistent across publishers' electronic

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journal applications. Secondly this link must, if possible, be to a version of an article that the user may access freely, maybe via a valid institution subscription. The latter problem is known as that of 'appropriate copy' [8]. A user would not be happy if linked to a publisher's web site where a copy of the article was available for a substantial fee if they were entitled to read the same article through a service with which they have a subscription.

3. Describing Bibliographic Resources

3.1. *zetoc* XML Records

As part of a project to develop enhancements to the ***zetoc*** service [9], the ***zetoc*** data was converted into 'Dublin Core in XML' records, the 'live' ***zetoc*** service using a proprietary database format. A prototype application was built to investigate providing access to this data. The reason for this development was to investigate the use of open standards and open source software. Holding the ***zetoc*** data in XML will provide greater flexibility for future reuse.

A problem experienced when trying to encode bibliographic citation information in Dublin Core is that there is not yet a recommended way to capture some of the data such as the journal title, volume and issue numbers, and the article page numbers. The problem of capturing the bibliographic information that effectively identifies and locates an article, within its own metadata record, has been considered over some time by the Dublin Core Metadata Initiative (DCMI) Citation Working Group [10]. The ***zetoc*** XML [11] follows a recommendation from that group, which was current at the time of data definition but has not been endorsed by DCMI.

3.2. Dublin Core Metadata for Bibliographic Citation Information

In October DC2002, the DCMI Usage Board approved a new Dublin Core term, 'bibliographicCitation', which is an element refinement of 'identifier', to be used for capturing the bibliographic information of a scholarly resource within its own metadata as a text string that could conform to some recognised citation style. The DCMI Citation Working Group proposed a 'Dublin Core structured value' (DCSV) [12], called 'DCMI Cite' [13] (see Figure 5). 'DCMI Cite' has been proposed to the DCMI Usage Board but has not yet been approved because it uses DCSV, which is currently under review. It enables the capture of the bibliographic citation for a journal article in a structured way that allows subsequent machine parsing while at the same time being relatively human readable. The current Dublin Core recommendation for encoding in XML [14] specifies a flat list of properties with no nested XML structure, thus precluding a structured XML form of 'DCMI Cite' within the 'bibliographicCitation' property.

4. The OpenURL Framework for Context-Sensitive Services

4.1. The ContextObject

The 'OpenURL Framework for Context-Sensitive Services' is a proposed ANSI/NISO standard, Z39.88-2003, currently a 'Draft Standard for Trial Use' [1]. It provides a way to describe a referenced resource, bundled together with the associated resources that comprise the context of the reference. This package is called a 'ContextObject'. The standard also defines flavours of 'OpenURL', which are methods of transporting these descriptions between networked systems. The ContextObject is the 'payload' of an OpenURL, but may also be an autonomous data object.

Typically, in a digital library context, a user will click on an OpenURL link in an HTML page, for example beside a citation within the reference list of an electronic journal article. The OpenURL for the reference will be passed to a linking server or resolver, which will return to the user a selection of resources pertinent to the cited article, preferably including a link to an appropriate copy of the full text of the article.

A ContextObject may contain up to six entities. One of these, the 'referent', holds information about the referenced resource. It must always be included in a ContextObject. The other five entities are: the resource where the reference occurs (referring entity); the user (requester); the service to which a request is sent (resolver); the service that generated the OpenURL (referrer); and the type of service requested.

Within the ContextObject, information about each entity may be detailed in four ways. An identifier within an indicated namespace will define a resource. A set of metadata, encoded as either 'by-value' or 'by-reference' may describe the entity. The difference is that a by-value metadata description is contained within the ContextObject, whereas a by-reference metadata description is held elsewhere at a URI identified in the ContextObject. The fourth type is undefined private data that requires a prior understanding between a resolver and a referrer.

Entities may be encoded in either 'Key / Encoded-Value' (KEV) Format or XML. KEV is a string of 'ampersand'-delimited pairs, each pair consisting of a label, or key, and an associated value, separated by an 'equals'. The value is 'URL-encoded', which means that special characters are translated into their equivalent hexadecimal byte strings to prevent their misinterpretation when transported by HTTP.

The OpenURL Framework is very general and has the potential to be used in many application domains and by many communities. Its core components are defined within the OpenURL Registry [15] [16]. For the current trial use period the content of this registry is pre-defined and static. It includes lists of identifier namespaces and metadata

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formats. A selection from the Registry of a consistent set of components appropriate to a particular application domain is a 'Community Profile', also defined in the Registry.

4.2. OpenURL for the Scholarly Information Community

The OpenURL Framework originated in the scholarly information community [17]. The OpenURL Framework San Antonio Community Profiles, pre-defined in the Registry, provide support for this community. The San Antonio Level 1 Profile provides a means of describing and transporting a reference and its context using the KEV format. The San Antonio Level 2 Profile caters for XML descriptions.

Within the scholarly information community the major application of the OpenURL Framework is to enable context-sensitive linking from a reference in a digital library system, such as an electronic journal application or an 'abstracting and indexing' service, to resources relevant to the referenced item. Before publication of the OpenURL Framework Standard, applications have been based on the draft OpenURL (now known as version 0.1) [18]. As indicated in the digital library scenario above, the result of a user activating an OpenURL link is to transport a description of a scholarly resource, such as a journal article, to a resolver, along with information about the dynamic context of the reference. Using OpenURL version 0.1, the information, or 'payload' of the OpenURL, is transported inline as the 'query string' of a URL. Passing the dynamic context enables the provision of a list of relevant services appropriate for the user. Typically an organisation's OpenURL resolver includes a knowledge base that records holdings, subscription and preference information specific to that organisation.

At first sight it seems that OpenURL version 1.0 has become over-complicated and more difficult to implement than the original draft OpenURL version 0.1. However, following the San Antonio Level 1 Profile for the scholarly information community [19], and using an 'inline' OpenURL, it is possible to upgrade current version 0.1 OpenURLs to version 1.0 OpenURLs without too much difficulty, as indicated in Section 5.2 below. The purpose of much of the extra functionality is to enable the generalisation of OpenURL [20] and thus its extension to other communities and application domains. OpenURL 0.1 already included the referent, the referrer (known as a 'sid') and the resolver (as the base URL). It was already possible to describe the entities by identifiers and by-value metadata. In reality, information about the requester, the referring entity and the preferred service type were being carried in version 0.1 OpenURLs as private data (the 'pid'), as was by-reference metadata. Formalising the method of encoding this currently private data will increase the interoperability of OpenURLs.

5. Locating Articles in *zetoc*

5.1. *zetoc* Source OpenURLs

zetoc now provides its users with the potential to link from a full record for an article to 'more information' about the article including the full text of the article if possible. This functionality is implemented using OpenURL, currently version 0.1, to provide a consistent linking syntax 'from' ***zetoc***. An example version 0.1 OpenURL as generated by ***zetoc*** from the full record citation data is shown in Figure 1.

Figure 1. An Example ***zetoc*** Journal Article version 0.1 OpenURL

(Not URL-encoded and with line breaks for readability)

```
http://example.org/myResolver?
sid=mimas:zetoc
&genre=article
&atitle=Phase compositions in
magnesium-rare earth alloys
containing yttrium, gadolinium or
dysprosium
&title=SCRIPTA MATERIALIA
&issn=1359-6462
&aulast=Apps&auinit=P. J.
&date=2003
&volume=48&issue=5
&spage=475&epage=481
```

(URL-encoded)

```
http://example.org/myResolver?sid=
mimas%3Azetoc&genre=article&atitle
=Phase+compositions+in+magnesium-
rare+earth+alloys+containing+yttri
um%2C+gadolinium+or+dysprosium&tit
le=SCRIPTA+MATERIALIA&issn=1359-
6462&aulast=Apps&aunint=P.+J.&date
=2003&volume=48&issue=5&spage=475&
epage=481
```

5.2. Upgrading *zetoc* to Provide Version 1.0 OpenURLs

In the future ***zetoc*** will be upgraded to provide version 1.0 OpenURLs. Figure 2 shows a version 1.0 OpenURL with an 'inline' ContextObject.

Comparing the examples in Figures 1 and 2, it can be seen that when upgrading from version 0.1 to version 1.0 the following changes have been made. Two 'url_' keys have been added to indicate the version of OpenURL and that the encoding is KEV. The 'sid' key has become the 'rfr_id' key and the encoding of the referrer has been upgraded. A 'rft_val_fmt' key has been added to indicate that the ContextObject contains by-value metadata for a 'journal type' referent, and the metadata keys have been

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prefixed by ‘rft.’ to show they apply to the referent. The metadata key for the journal title has been changed to the preferred form of ‘jtitle’.

Figure 2. ***zetoc*** Journal Article version 1.0 OpenURL

(Not URL-encoded and with line breaks for readability)

```
http://example.org/myResolver?
url_ver=z39.88-2003
&url_ctx_fmt=ori:fmt:kev:mtx:ctx
&rfr_id=ori:rfr:mimas.ac.uk:zetoc
&rft_val_fmt=
    ori:fmt:kev:mtx:journal
&rft.genre=article
&rft.atitle=Phase compositions in
magnesium-rare earth alloys
containing yttrium, gadolinium or
dysprosium
&rft.jtitle=SCRIPTA MATERIALIA
&rft.issn=1359-6462
&rft.aulast=Apps&rft.aufirst=P. J.
&rft.date=2003
&rft.volume=48&rft.issue=5
&rft.spage=475&rft.epage=481
```

(URL-encoded)

```
http://example.org/myResolver?
url_ver=z39.88-
2003&url_ctx_fmt=ori%3Afmt%3Akev%3
Amtx%3Actx&rfr_id=ori%3Arfr%3Amima
s.ac.uk%3Azetoc&rft_val_fmt=ori%3A
fmt%3Akev%3Amtx%3Ajournal&rft.genr
e=article&rft.atitle=Phase+composi
tions+in+magnesium-
rare+earth+alloys+containing+yttri
um%2C+gadolinium+or+dysprosium&rft
.jtitle=SCRIPTA+MATERIALIA&rft.iss
n=1359-
6462&rft.aulast=Apps&rft.aufirst=P
.+J.&rft.date=2003&rft.volume=48&r
ft.issue=5&rft.spage=475&rft.epage
=481
```

zetoc does not include global identifier descriptors in its source OpenURLs. If it did, it would be necessary to use the key ‘rft_id’ rather than ‘id’ and to use an identifier namespace from the OpenURL registry. Thus an example PubMed identifier within a version 0.1 OpenURL

```
id=pmid:9036860
```

would become in version 1.0

```
rft_id=ori:pmid:9036860
```

5.3. OpenURLs for Conference Papers

zetoc contains records of conference papers as well as journal articles. Some conference papers are published in journals so the ***zetoc*** record includes both journal citation and conference proceedings information. Using OpenURL version 0.1, a conference paper OpenURL link is similar to that shown in Figure 1, except that the ‘genre’ indicates ‘proceeding’, and the conference proceedings title and ISBN are included, the journal information being omitted when the paper is not in a journal. Using version 1.0 OpenURL it will be necessary to make a distinction between conference papers that are in journals and those in book proceedings. An OpenURL for the former will be similar to the example in Figure 2, and will not include the proceedings information. A 1.0 OpenURL for the latter will use the book metadata format, as shown in Figure 3.

Figure 3. ***zetoc*** Conference Paper version 1.0 OpenURL

(Not URL-encoded and with line breaks for readability)

```
http://example.org/myResolver?
url_ver=z39.88-2003
&url_ctx_fmt=ori:fmt:kev:mtx:ctx
&rfr_id=ori:rfr:mimas.ac.uk:zetoc
&rft_val_fmt=ori:fmt:kev:mtx:book
&rft.genre=proceeding
&rft.atitle=Exposing Cross-Domain
Resources for Researchers and
Learners
&rft.btitle=Dublin Core and
metadata for e-communities; DC-
2002 metadata for e-communities,
supporting diversity and
convergence
&rft.isbn=8884530431
&rft.aulast=Apps
&rft.aufirst=A.
&rft.date=2002
&rft.spage=70
&rft.epage=80
&rft.pub=Firenze University Press
```

(URL-encoded)

```
http://example.org/myResolver?
url_ver=z39.88-2003
&url_ctx_fmt=ori%3Afmt%3Akev%3Amtx
%3Actx&rfr_id=ori%3Arfr%3Amimas.ac
.uk%3Azetoc&rft_val_fmt=ori%3Afmt%
3Akev%3Amtx%3Abook&rft.genre=proce
eding&rft.atitle=Exposing+Cross-
Domain+Resources+for+Researchers+a
nd+Learners&rft.btitle=Dublin+Core
+and+metadata+for+e-
communities%3B+DC-
2002+metadata+for+e-
communities%2C+supporting+diversit
y+and+convergence&rft.isbn=8884530
431&rft.aulast=Apps&rft.aufirst=A.
&rft.date=2002&rft.spage=70&rft.ep
age=80&rft.pub=Firenze+University+
Press
```


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5.4. Hybrid OpenURLs

In reality, there will be a transition period of indeterminate length while applications are upgrading to version 1.0. This poses a problem for referrers. In order to continue providing a quality service to end users, ***zetoc*** will have to continue to supply version 0.1 OpenURLs until it is certain that all clients' resolvers have been upgraded. Thus when ***zetoc*** first upgrades it will generate hybrid OpenURLs containing both version 1.0 and version 0.1 keys where these differ. It is expected that OpenURL resolvers will deal gracefully with foreign keys that they do not understand by ignoring them.

5.5. Location via a Resolver

For ***zetoc*** users whose institutions have an OpenURL resolver the OpenURL query is passed to that resolver. When such a user activates the 'more information' link they immediately see the menu of their appropriate resolver, as defined by their institution, which will include a link to the full text of the article if the institution has a valid subscription. Thus a user receiving a ***zetoc*** alert email about an article of interest can follow the URL in the email directly to the full record in ***zetoc***, the 'more information' link to their institution's OpenURL resolver, then the link from the displayed menu to the full text of the article. They can very easily, with a small number of 'clicks', reach the full text of an article from a ***zetoc*** alert.

The problem when implementing OpenURL linking from an information service is that of knowing to which resolver to send the OpenURL query. Some services allow the registration of organisations' resolvers and are able to correlate users and their organisations. But some information providers, particularly freely available services, are unable or unwilling to record the addresses of resolvers. There are several possible solutions to this problem such as the use of 'cookies' [21], or the provision of OpenURL routing services.

Authentication to use ***zetoc*** is performed by IP address checking and failing that by Athens [22], the UK Higher and Further Education authentication system. The Athens three-letter prefix, which is specific to each institution, is used as the institution identifier. For those users who are allowed access to ***zetoc*** by IP address a correlation is made to determine their institution identifier. If an institution wishes to use ***zetoc*** as an OpenURL source they can register the address of their OpenURL resolver by contacting the ***zetoc*** helpline. These resolver addresses are recorded in an 'institution information' XML file, which is also used to record information to provide customised 'inter-library loan' facilities. When a user selects the 'more information' link from a ***zetoc*** full record their institution identifier is determined from their login authentication. The resolver address recorded for the appropriate institution is used as the base URL for the OpenURL link.

zetoc has worked with several vendors of OpenURL resolvers to verify that ***zetoc*** OpenURL source links interoperate with their products. Currently ***zetoc*** has registered OpenURL resolvers for 9 institutions using OpenURL resolvers from several vendors: SFX from Ex Libris [23]; 1Cate from Openly Informatics [24]; LinkFinder Plus from Endeavor [25]; and WebBridge from Innovative Interfaces [26]. ***zetoc*** has also provided testing for LinkSource from EBSCO [27].

5.6. Default Location

Where a user's institution has not registered an OpenURL resolver with ***zetoc***, the user is shown a default ***zetoc*** 'More Information' page. For all users this page contains a link to COPAC [28], the UK research libraries' online catalogue, providing information to assist in locating print copies of journals and conference proceedings.

For users in UK academia, that is those who are accessing from computers in the '.ac.uk' domain, an 'online article search' link is shown. This is an OpenURL link to MDL's LitLink [29] resolver for which MIMAS [30] has a licence to provide access to UK academia. LitLink provides access to many electronic journal articles via applications such as Elsevier's ScienceDirect [31]. There is no guarantee that a particular user will be allowed to access the full text of an article, so this is not an ideal 'appropriate copy' link. But there will be sufficient occasions when a direct link to full text is available to advise ***zetoc*** users who are shown this link that: "It's worth a try, but access can't be guaranteed".

5.7. Alternative Full Text Links

An alternative possibility for providing links to the full text of journal articles would be CrossRef [32]. CrossRef is a collaboration between publishers of scholarly information providing a reference linking service that allows the user to click on a citation and be taken directly to the target content. The citation links are Digital Object Identifiers (DOIs) [33]. Use of CrossRef has not been explored for ***zetoc*** because the ***zetoc*** data does not currently contain DOIs. Looking up the DOIs for the quantity of records in ***zetoc*** would be a major undertaking. Currently CrossRef appears to provide a direct link to the full text of a journal article on the publisher's site to which a user may not have a subscription. Whereas a link via an OpenURL resolver can provide an appropriate copy link plus links to related services, but requiring a few more 'clicks' by the user. Some of these links provided by OpenURL resolvers are in fact implemented via CrossRef.

5.8. Location Usage

From logged usage statistics, the ***zetoc*** 'more information' link has proved to be popular since its

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introduction in November 2002. In April 2003 there were 430 clicks on the 'more information' link to an institution's OpenURL resolver and 7832 to the default. From the latter, there were 4166 accesses to the 'online article search' (LitLink) link, 1790 clicks on a COPAC journal search and 192 to a COPAC book (proceedings) search. A follow up user evaluation study is planned, the earlier study predating the introduction of this functionality.

5.9. 'Link-to' *zetoc* via OpenURL

In addition to providing OpenURL source links 'from' ***zetoc***, ***zetoc*** is enabled as a 'link-to' OpenURL resolver, providing an access point to its content. Subject to normal authentication restrictions, it is possible to search ***zetoc*** using an OpenURL as 'link to' syntax, directly to a full record when sufficient data is included. Thus ***zetoc*** is available as an OpenURL-compliant OpenURL target, providing a standard rather than a proprietary syntax to resolvers and other applications wishing to link directly into ***zetoc*** records. Again this functionality is currently based on version 0.1 OpenURL.

6. Using ContextObjects for Dublin Core Bibliographic Citations

6.1. Citations as Text Strings

When it becomes an ANSI/NISO standard, an OpenURL Framework ContextObject including KEV by-value metadata would be suitable as a string to be used as the content of a Dublin Core 'bibliographicCitation' property. It has previously been suggested that OpenURL version 0.1 could be used to identify a bibliographic resource as a parsable string [34]. Although that was a viable approach, it used a partial OpenURL, the query string without the base URL, which raised a question of validity according to the standard. A ContextObject, on the other hand, may exist as an autonomous data object making valid its use as the value of a Dublin Core property. Currently KEV by-value metadata formats in the OpenURL Registry and subscribed to by the San Antonio Level 1 Profile are for: journals and parts of journals; books and parts of books, including conference proceedings, reports and simple documents; dissertations; and patents. Figure 4 shows an example of a 'bibliographicCitation' property using a KEV ContextObject, accompanied by a plain text version of the citation. This is only a part of the Dublin Core metadata record for an article, which would capture other details such as the article title and authors using other Dublin Core properties.

A drawback to using a KEV ContextObject to describe a bibliographic resource is its poor human readability. According to the NISO draft standard, a by-value KEV ContextObject must be URL-encoded to be 'transport ready'. Using such a ContextObject as the content of a Dublin Core property would be a viable option for an application that reformatted data before display to an end-user. But it is not really suitable for general resource discovery unless accompanied by a repeated 'bibliographicCitation' showing the equivalent simple text string, as in Figure 4. Thus for journal articles it may be an alternative to the proposed 'DCMI Cite' structured value, but not a replacement for it. But no similar structured value is currently proposed for the other genre that the OpenURL San Antonio Level 1 Profile includes. Figure 5 shows the same example encoded using 'DCMI Cite'. It is important to include sufficient information in a 'DCMI Cite' to identify a journal article. It should not be used within an article metadata record to identify a parent resource such as the journal, for which the relation 'isPartOf' would be used.

Figure 4. A Dublin Core Bibliographic Citation Property

```
<dcterms:bibliographicCitation>
  Library and Information Science
  Research 22(3), 311-338 (2000)
</dcterms:bibliographicCitation>
<dcterms:bibliographicCitation
    xsi:type="Z39.88-2003">
  ctx_ver=z39.88-
2003&rft_val_fmt=ori%3Afmt%3Akev%3
Amtx%3Ajournal&rft.jtitle=Library+
and+Information+Science+Research&r
ft.stitle=LISR&rft.volume=22&rft.i
ssue=3&rft.spage=311&rft.epage=338
&rft.date=2000&rfr_id=ori%3Arfr%3A
mimas.ac.uk%3Azetoc
</dcterms:bibliographicCitation>
```

Figure 5. A DCMICite Bibliographic Citation Property

```
<dcterms:bibliographicCitation
    xsi:type="DCMICite">
  journalTitle=Library and
    Information Science Research;
  journalAbbreviatedTitle=LISR;
  journalVolume=22;
  journalIssueNumber=3;
  pagination=311-338;
  journalIssueDate=2000
</dcterms:bibliographicCitation>
```

The citation properties shown in the above examples are those for a resource within its own metadata record, that is an internal document 'in' link. The DCMI Cite proposal was developed to address a perceived deficiency in Dublin Core that there is no recommended way to record the bibliographic information for a journal article within the metadata record for that article. But it would also be possible to use one of the above solutions as

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content for a relation ‘references’ property to record a citation reference to another resource, that is an external ‘out’ link. It is questionable whether one should include metadata for another resource within a Dublin Core record. However, in reality, applications concerned with reference linking will implement this functionality.

6.2. XML Citation Records

An XML OpenURL Framework ContextObject provides a possible solution to the problem of capturing the citation information for a bibliographic resource within its own XML metadata record. Currently XML metadata formats in the OpenURL Registry and subscribed to by the San Antonio Level 2 Profile include: journals and parts of journals; books and parts of books, including conference proceedings, reports and simple documents; dissertations; and patents. A metadata record for a bibliographic resource such as a journal article could be a combination of its Dublin Core and its ContextObject XML metadata format properties, as shown in Figure 6. This follows the guidelines for mixing Dublin Core metadata with other metadata schemas [14].

Figure 6. An XML Metadata Record for a Journal Article

```
<?xml version="1.0"?>
<record
  xmlns:dc=
"http://purl.org/dc/elements/1.1/"
  xmlns:xsi=
"http://www.w3.org/2001/XMLSchema-
instance"
  xsi:schemaLocation=
"http://purl.org/dc/elements/1.1/
http://dublincore.org/schemas/xmls
/qdc/2003/04/02/dc.xsd"
  xmlns:dcterms=
"http://purl.org/dc/terms /"
  xsi:schemaLocation=
"http://purl.org/dc/terms/
http://dublincore.org/schemas/xmls
/qdc/2003/04/02/dcterms.xsd"
  xmlns:ctx=
"http://www.openurl.info/ori/fmt/x
ml/xsd/ctx"
xsi:schemaLocation=
"http://www.openurl.info/ori/fmt/x
ml/xsd/ctx
http://www.openurl.info/registry/d
ocs/ori/xsd/ori:fmt:xml:xsd:ctx"
  xmlns:rft=
"http://www.openurl.info/ori/fmt/x
ml/xsd/journal"
xsi:schemaLocation=
"http://www.openurl.info/ori/fmt/x
ml/xsd/journal
http://www.openurl.info/registry/d
ocs/ori/xsd/ori:fmt:xml:xsd:journa
l">
<dc:title>Streak-line Defect
  Minimization in Multi-layer
  Slide Coating Systems</dc:title>
<dc:creator>
  Noakes, C.J.</dc:creator>
<dc:subject
    xsi:type="dcterms:DDC">
  660</dc:subject>
<dc:publisher>
  The Institute of Chemical
  Engineers</dc:publisher>
<dcterms:issued
    xsi:type="dcterms:W3CDTF">
  2002</dcterms:issued>
<dc:type
    xsi:type="dcterms:DCMIType">
  Text</dc:type>
<dc:language
    xsi:type="dcterms:RFC1766">
  en</dc:language>
<dcterms:isPartOf
    xsi:type="dcterms:URI">
  urn:issn:0263-8762
</dcterms:isPartOf>
<dcterms:bibliographicCitation>
  Chemical Engineering Research
  and Design 80(5), 449-463 (2002)
</dcterms:bibliographicCitation>
<ctx:context-object
    version="z39.88-2003">
<ctx:referent>
<ctx:metadata-by-val>
<ctx:format>
  ori:fmt:xml:xsd:journal
</ctx:format>
<ctx:metadata>
<rft:journal>
<rft:jtitle>
  Chemical Engineering Research
  and Design</rft:jtitle>
<rft:volume>80</rft:volume>
<rft:issue>5</rft:issue>
<rft:spage>449</rft:spage>
<rft:epage>463</rft:epage>
<rft:date>2002</rft:date>
</rft:journal>
</ctx:metadata>
</ctx:metadata-by-val>
</ctx:referent>
<ctx:referrer><ctx:identifier>
  ori:rfr:mimas.ac.uk:zetoc
</ctx:identifier></ctx:referrer>
</ctx:context-object>
</record>
```


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DCMI does not currently recommend any nested XML structure for Dublin Core properties. This means it is not possible to indicate by the XML structure in this combined record that the ContextObject contains details pertinent to the 'bibliographicCitation' property. Thus it would not be possible to use this approach to capture citation linking information for a 'references' property because there is no way to distinguish between the two uses of a ContextObject in an XML document. It would be possible to make this correlation between a Dublin Core property and an XML ContextObject using an XML attribute link, but this would not be following a current Dublin Core recommendation. Figure 7 shows suggested amended properties in an abbreviated record, with namespace declarations omitted for brevity. The namespace 'myns' is local to the application, 'myns:ref' tying to the 'identifier' of a ContextObject.

Figure 7. An XML Metadata Record for a Journal Article including References (abbreviated)

```
<record>
<dc:title>
  Prototyping Digital Library
  Technologies in zetoc
</dc:title>
<dcterms:isPartOf
    xsi:type="dcterms:URI">
  urn:issn:0302-9743
</dcterms:isPartOf>
<dcterms:bibliographicCitation
    myns:ref="#bibcite">
  Lecture Notes in Computer
  Science 2458, 309-323 (2002)
</dcterms:bibliographicCitation>
<dcterms:references
    myns:ref= "#ref1">
  Apps, A., MacIntyre, R. zetoc: A
  Dublin Core Based Current
  Awareness Service. Journal of
  Digital Information 2(2)
  (2002)
</dcterms:references>
<dcterms:references
    myns:ref= "#ref2">
  Carnall, D. Website of the week:
  Email alerting services. British
  Medical Journal 324, 56
  (2002)
</dcterms:references>
<ctx:context-objects>
<ctx:context-object
    version="z39.88-2003"
    identifier="bibcite">  …
<rft:journal>
<rft:jtitle>
  Lecture Notes in Computer
  Science
</rft:jtitle>
<rft:volume>2458</rft:volume>
<rft:spage>309</rft:spage>
<rft:epage>323</rft:epage>
<rft:date>2002</rft:date>
</rft:journal>  …
</ctx:context-object>
<ctx:context-object
    version="z39.88-2003"
    identifier="ref1">  …
<rft:journal>
<rft:atitle>
  zetoc: A Dublin Core Based
  Current Awareness Service
</rft:atitle>
<rft:author>
  <rft:aulast>Apps</rft:aulast>
  <rft:auinit>A</rft:auinit>
</rft:author>
<rft:author>
  <rft:aulast>MacIntyre
  </rft:aulast>
  <rft:auinit>R</rft:auinit>
</rft:author>
<rft:jtitle>
  Journal of Digital Information
</rft:jtitle>
<rft:volume>2</rft:volume>
<rft:issue>2</rft:issue>
<rft:date>2002</rft:date>
</rft:journal>  …
</ctx:context-object>
<ctx:context-object
    version="z39.88-2003"
    identifier="ref2">  …
<rft:journal>
<rft:atitle>
  Website of the week: Email
  alerting services
</rft:atitle>
<rft:author>
  <rft:aulast>Carnall</rft:aulast>
  <rft:auinit>D</rft:auinit>
</rft:author>
<rft:jtitle>
  British Medical Journal
</rft:jtitle>
<rft:volume>324</rft:volume>
<rft:spage>56</rft:spage>
<rft:date>2002</rft:date>
</rft:journal>  …
</ctx:context-object>
</ctx:context-objects>
</record>
```


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7. Conclusion

The ***zetoc*** service enhancement to provide quick access to the full text of recorded articles where possible is popular and well used. The implementation of links to services pertinent to the recorded article and appropriate for the user is possible because of the existence of institution-specific OpenURL resolvers. For those users in UK academia whose institution has not registered an OpenURL resolver with ***zetoc***, a default OpenURL resolution service is provided by MDL LitLink, in many cases allowing users access to the full text of articles.

zetoc aims to provide researchers with a means to find and access published research material to aid in the furtherance of their own research, thus assisting in the advancement of knowledge. Within an internet cross-referencing paradigm of 'discover – locate – request – deliver' [35], ***zetoc*** provides 'discovery' of research articles in a timely manner, and 'request and deliver' traditional document delivery services. ***zetoc*** can now provide 'location' of 'appropriate copies' of articles via institutions' OpenURL resolvers, which provide 'request and deliver' internet services.

The OpenURL Framework ContextObject appears to provide a standard way of capturing bibliographic information within a Dublin Core metadata record. In particular its use seems appropriate within XML metadata records for scholarly information resources such as journals and their issues and articles, conference proceedings and papers, and books.

This paper presents a use for the OpenURL Framework within the scholarly information community where it originated. Within the digital library world many applications are already using OpenURLs. Because it enables links that are appropriate for the user between resources the OpenURL standard, to quote NISO, "puts thinking back in linking".

But the OpenURL framework is very general. With OpenURL registration of appropriate identifier namespaces and metadata, its linking technology has the potential to be used in diverse communities and applications. Referents do not have to be scholarly resources. To quote Herbert Van de Sompel [36]: "We could start seeing new generation OpenURLs for cars, real estate, music, pizzas, and domain-specific linking servers that deliver overlay services. A dynamic, personalised link structure on top of the existing static Web link structure."

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