Opening Up Knowledge Links: New Standards for a New Age

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> *"I liked the idea that a piece of information is really defined only by what it is related to, and how it is related.*
>
> *Berners-Lee (1999)"*

1. Whence the Black Hole?

As researchers make greater use of electronic resources, especially the journal literature, there is a growing need to more effectively find and use these resources. The problem is complicated by the fact that many electronic resources do not have single instance on the Web, but may reside in many different locations. Content may live in aggregations, at local load sites, directly from the publisher (or mirror sites), or from other vendors that may be collecting, archiving and distributing access. Traditionally, researchers search the journal literature through indexing/abstracting services or table-of-contents services. One of the benefits in this technique is that controlled vocabulary and other mechanisms are employed to help improve precision and recall in searching. Many indexing/abstracting services are beginning to look at how to link to full-text over the Web so that a patron does not need to leave their system to get to the full-text.

One approach that proprietary vendors have used is to create their own linking mechanisms. One of the problems with these linking solutions is that even if they are linking to full-text content outside of their own full-text offerings, the subscriber must build and maintain these links in the local service. If there is only one local service provider, that may be fine. But if a library subscribes to more than one service provider, things tend to become complicated.

This problem has mitigated to some extent, through the development of OpenURL technology that defines a standardized way in which to store and query metadata for content to which a library subscribes. Through the maintenance of a single OpenURL compliant database, libraries can define only once what they subscribe to and database vendors can activate an executable piece of software on their system that can direct users of a specific library to a resolver that knows what is available [Walker, 2001].

2. OpenURL: Is that a workable solution?

The OpenURL concept was developed by Herbert Von de Sompel (and Patrick Hochstenbach) in 1999 in a series of papers he wrote as part of his work on his PhD dissertation at the University of Ghent [Von de Sompel & Hochstenbach, 1999a, 1999b, 1999c]. In this series of groundbreaking papers in the library community, the author describes the problem and offers a solution on how to practically solve the issue of getting libraries to the "appropriate" copy of an electronic resource to which they have subscribed. He implemented test OpenURL resolvers at both the Los Alamos National Laboratory (LANL) and the University of Ghent. Subsequently, Ex Libris, was the first commercial vendor to develop and implement a commercial version of the SFX OpenURL linking solution proposed by Von de Sompel.

How does OpenURL work?

> "*The OpenURL provides a mechanism for encoding citation for an information resource, typically a bibliographic resource, as a URL. The OpenURL is, in effect, an actionable URL that transports metadata, or keys to access metadata, for the*

> *object for which the OpenURL is provided. The target of the OpenURL is an OpenURL resolver that offers context-sensitive services based on that metadata... An OpenURL comprises two parts, a BASEURL and a QUERY. The BASEURL identifies the OpenURL resolver that will provide context sensitive services for the OpenURL. The BASEURL is specific to the particular user that is being sent the OpenURL - it identifies the user's preferred OpenURL resolver. In many cases this will be the resolver offered by the institution to which the user belongs. Services that embed OpenURLs in their Web interfaces, for example in their search results, must develop mechanisms for associating a BASEURL with each end-user. One way of doing this is to store the BASEURL in a cookie in the user's Web browser, another is to store the BASEURL along with other user preferences*." [Powell, 2001].

In simple English, the library or consortium has scores of databases and possibly thousands of journals in full-text form from various content aggregators. It also has many books and journals as well as access to consortial and regional catalogs showing even broader print holdings. OpenURL links article citations and other items in enabled databases to full-text resources, local print holdings, and other features that enhance access. With OpenURL, the library or consortium runs a "resolver" software that knows your site, the full-text or other resources you have available, and how to reach them. When a user clicks on a link, the resolver identifies what services are available for that particular item at your institution and provides the tools for whatever next step the user chooses. By looking at an OpenURL it is possible to see the various elements of a typical citation such as the article title, author, journal title, journal ISSN, volume, issue, pages, etc. When a structured OpenURL is presented to an OpenURL resolver, it can be parsed into its individual elements and presented to a table of what the library owns. The user will then be presented with a series of options of where the full-text (or other related resources) for this citation is available and the user can link to a final destination [Stern, 2001]. Typically, a link to an OpenURL resolver could be found in indexing/abstracting services, library catalogs, or even in full-text articles where references may be found. These sources need to be OpenURL enabled in which a small executable piece of software resides on the service. When a user logs in, the system will know with which institution that person belongs so that the OpenURL link can be specific to the site of the user. Once a user activates the OpenURL link, the software will extract the necessary metadata from the citation and present it to the patrons resolver [Information Today, 2001].

Reference linking has become the answer for assisting users in finding full-text on the Web. It will only be a matter of time before virtually all libraries will need to have this type of technology integrated into their online systems. It makes sense for established index and citation databases to link to existing full-text resources rather than ask libraries to license the same sources yet again. OpenURL makes that easy, and it might help libraries minimize duplication of resources in future negotiations. If properly implemented, OpenURL is a win-win situation. Good abstracting and indexing services become more valuable by linking to local resources. Licensed resources and print holdings see more use because the link from identification to holdings is fast and easy. OpenURL is different to Z39.50* which – although still very much alive - is a pure computer-to computer standard. OpenURL adds natural intelligence to the computer-to-computer process to navigate complexity. OpenURL resolvers don't take metadata and immediately hand off whatever resource comes up--a process that will frequently fail because the metadata is incomplete or because the source database and the object resource follow different rules. Instead, resolvers apply as much logic as they can, then offer the user a menu showing a range of possibilities. It involves the user's natural intelligence in navigating the complex field of library resources, both online and in print. That offers more power than a pure computer-to-computer protocol-and, well, it makes it more fun [Crawford, 2002]. Given universal adoption of the ***OpenURL*** syntax as a standard for data delivery, it is possible to network a variety of search engines, local resolvers, and data repositories

* An ANSI standard query language that is a simplified version of SQL. It is used on the Internet to search for documents.

to provide interoperability across both local and remote computers. The next significant steps will be the development of the many smart search agents, the local resolver databases, and the metadata required to create truly enhanced one-stop discovery and delivery systems.

However, a word of warning is in order: early OpenURL resolvers seem to be high priced and need substantial work to make them properly work. The most difficult part for libraries will be populating their local resolvers with what they own. Available OpenURL products (eg. ExLibris, Innovative Interfaces, Endeavor, etc.) are still in their infancy. For OpenURL to really be effective, some international collaboration is required: international efforts for article level linking through CrossRef must be tied to local OpenURL resolvers to make sure that the patron is getting to the appropriate copy of an article. Some other issues are:

- All full-text is not the same. Full-text from an aggregrator with selected content or only the ASCII text is not as valuable as an original image of the article as intended by the publisher. Resolvers should have the ability to display links emphasizing the more important content first.
- Dates of coverage for full-text content need to be clearly displayed. Ideally, links would be filtered to avoid showing resources that are outside of the years of coverage of a particular citation. However, this is often difficult because title lists from different sources that may be used to populate resolvers are not uniform in their date representations.
- Interactive links between article level services such as CrossRef need linking to local ownership as reflected in an institutional resolver.
- Web interfaces in library catalogs need to be OpenURL compliant even if a library chooses not to buy the resolver from the same company.

3. What is the Extended Service Link?

It is difficult to write about the Extended Services notion in a non-technical manner. They constitute part of the Web Services Platform. Web-based applications that dynamically interact with other Web applications using open standards that include XML, UDDI and SOAP. Such applications typically run behind the scenes, one program "talking to" another (server to server). Microsoft's .NET and Sun's Sun ONE (J2EE) are the major development platforms that natively support these standards.

Web services have been initially successful in private environments where large enterprises need to exchange data with their divisions and subsidiaries or with partners and clients. In such controlled situations, agreement on the data being passed between Web service components may be unilateral or easily obtained. In addition, since Web services use open standards, vendors can supply customers with client side software to add to their applications no matter what the platform. Web services over the public Internet are another story that is expected to materialize over the next several years. Using the UDDI discovery system, the goal is to register the service on the Internet, allow an application to search for and find the service and then to seamlessly exchange data with it. If the service is fee based, payment processing could be included. For global services to be successful, industries must define the details of every function that such a service must provide before it is put into operation. Web services enable software components to interact with each other around the world. In the past, this has only occasionally been realized within private networks using the industry standard CORBA and Microsoft's DCOM distributed component platforms. However, Web services use XML-based protocols that are lightweight and simpler in comparison. Although the term became the hot buzzword at the turn of the century, Web services still require cooperation and agreement among people to define business transactions and processes. Web services standards only define the format and transport architectures, but the meaning of each element of data exchanged also has to be defined ahead of time by industry consensus [Allan & Hanlon, 2002).

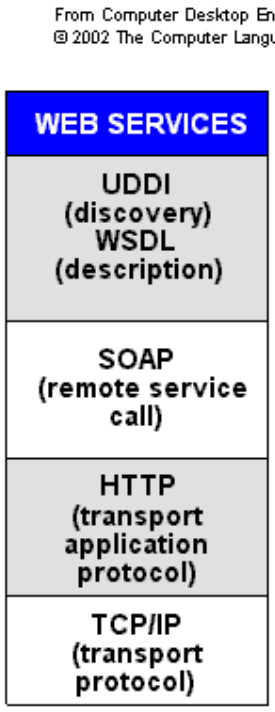

Fig. 1 UDDI is used to register and discover Web services, typically described in WSDL. The UDDI transactions use SOAP to talk to the UDDI server, and then the application uses SOAP to request the Web service. SOAP messages are actually delivered by HTTP and TCP/IP.

But the above is not the only definition of "extended services" in digital information management. In cataloguing, the SQL-based query language Z39.50 also has an "extended services" definition. OCLC supports setting institution holding symbols and producing catalog cards via the Z39.50-1995 DatabaseUpdate Extended Service Definition. The "extended services definition" is the general definition of how OCLC has implemented these Z39.50-1995 capabilities in its target server. The latest update of that definition (1999) can be found on the OCLC website [http://www.oclc.org/oclc/cataloging/z3950/zcat_dbupdate.htm].

One of the new features in Z39.50 version 3 is the ability to order an item using the Extended Services (Extended Services) specifications. The Extended Services service is rather peculiar because the services that can be requested via Extended Services are not Z39.50 services in themselves, but are functions supported by the remote server system that are executed external to a Z39.50 session. Extended Services services relate to information retrieval but go beyond the specific activities associated with database searching and record retrieval as defined by the standard. Standardised Extended Services services include:

- Save a result-set for later use;
- Save a search query for later use;
- Define a periodic search schedule;
- Update a database: add, replace, delete records;
- Specify the delivery destination (printer, fax);
- Order an Item [Corthouse & Philips, 1996]

These all represent services for which information may need to be kept beyond the file of Z39.50 association in which they were requested. Many of these Extended Services services already exist as features in information retrieval systems such as online catalogues. When the origin asks for an Extended Services service, this results in an Extended Services task. The execution of this Extended

Services task is not part of the Z39.50 association, but is performed by the target outside the association as a separate function or within another application. For example, the processing of an item request will normally occur after the order has been received and after the Z39.50 session was closed. The standard does not specify how the target should fulfil the task, e.g. does not define how the target is to process the item order. The acceptance of an Extended Services task by the target system results in the creation of a Task Package. This Task Package is a record containing information pertaining to the task and is kept in a special Extended Services database maintained by the target. The information contained in a task package is a combination of data supplied by the origin and data supplied by the target. Two types of information are maintained in the task package: information that is common to all Extended Services task packages and information that is specific to each type of task package. Even though the execution of an Extended Services task in conducted outside Z39.50 (e.g. the actual supply of the item is outside the scope of the Z39.50 standard), the origin system (client) can retrieve information pertaining to the requested task by using the services of the Z39.50 standard to search the Extended Services database.

Again, for the sake of simplicity, all “extended services” in digital context are specifications used to write compliant software. Both examples given above are about information retrieval. Extended services standards only define the format and transport architectures, but the meaning of each element of data exchanged also has to be defined ahead of time by industry consensus.

Having indulged in techno-speak, one needs to relate this to OpenURL and the linking software using the standards. Before we can do this, we need to introduce an intermediate piece of software, SFX.

Traditional linking has a number of weak points:

- Links are calculated and embedded in documents at the time of creation of the documents. To create these 'static' links, the information service provider must have knowledge, at the time, of all resources to be interlinked. This approach cannot easily be scaled up to deal with large numbers of resources, it may cause delays in the delivery of information and the resulting links may not be reliable.
- Solutions that rely on dynamic rather than static linking, whereby the links are calculated at the time the user requests the link, tend to be 'closed' solutions. Such solutions put control of the linking in the hands of the information service providers, which are focused on maximising the link traffic to their sites, rather than in the hands of the librarian, who would like to maximise usage of the varied resources for which the institution has already subscribed.
- The scope of the links offered to users is limited typically to full-text retrieval, or to holdings lookups in online catalogues. Little, if any, provision is made for a richer range of extended service links, such as those for citation database searches, related web searches and online bookstores.
- Links will appear in information resources regardless of whether users have rights of access to the information resource or service to which they are linking. Users may click on a link only to discover that they are barred from access to the service. This leads to frustration and in some cases may result in the user purchasing a service for which the institution has already paid, but via an alternate provider.
- Despite today's interlinked world where in theory it is possible to access a single version of a resource no matter where it is hosted in the world, it is still possible for many copies of an article to exist in electronic form. Although this in itself is a good thing, it might be that the appropriate copy of an article is not an electronic one for which the library has a subscription, but rather the print one in a journal on the library shelves.

In 1999, Herbert Van de Sompel and his team at Ghent University in Belgium developed a link server to address not only the 'appropriate copy' problem but also the other constraints on linking that were prevalent at the time, and largely remain today. SFX has been called the “missing digital link”, but it is far more sophisticated than the Alduvai Lucy. The software provides the solution to

the traditional linking weak point: whereas the later is controlled by the source, dependent on specific business agreements and limited to FTXT and print holdings, the former uses a link server/resolver (OpenURL standards) that is context sensitive and receives *Metadata* about Objects (referents) on the OpenURL and resolves it into Service Links to appropriate Targets. This enables SFX to provide localized extended services, i.e. context-sensitive linking between heterogeneous resources (Beit-Arie, 2002). The scope of the links offered by traditional linking to users is limited typically to full-text retrieval, or to holdings lookups in online catalogues. Little, if any, provision is made for a richer range of extended service links, such as those for citation database searches, related web searches and online bookstores.

Fig. 1. In the 'old' way of linking, the resolution of links is determined by the link source. [Walker, 2001b]

SFX is a tool for navigation and discovery, delivering powerful linking services in the scholarly information environment. With SFX, libraries can define rules that allow SFX to dynamically create links that fully integrate their information resources regardless of who hosts them -- the library itself or external information providers. The user is presented with context-sensitive links that are dynamically configured on the basis of the institution's e-collections. Such resources could include:

- full-text repositories;
- abstracting, indexing, and citation databases;
- online library catalogs; and ·
- citations appearing in research articles, e-print systems, and other Web resources.

SFX permits context-sensitive linking between these web-based resources; whereby the target of a link depends on the digital library collection of the institution to which the user who requested the link is affiliated. No more "dead" links whereby the user clicks on a link to navigate to a new information space but finds that they do not have rights of access to the resource to which they have linked and are therefore blocked from access. SFX allows the librarian to define the library's electronic collection, including both licensed and freely available resources; and to determine the manner in which the component resources can be linked to best suit the library's users [Van de Sompel et. Al,2000).

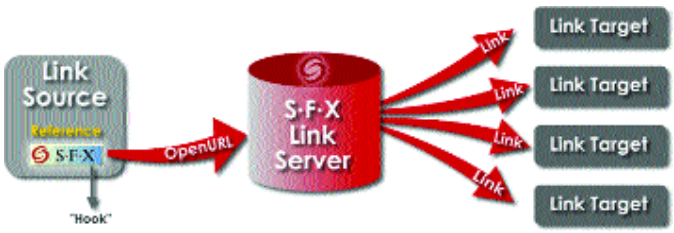

Fig. 3. Smart linking is accomplished by disconnecting the link source from the link target, and inserting a link server, such as an SFX server, in the linking process. The link source provides a 'hook', and the link server accomplishes the context-sensitive resolution of links to their appropriate target(s). [Walker, 2001b]

So how does the OpenURL operate in SFX? The OpenURL is a protocol for interoperability between an information resource and a service component that offers localized services in an open linking environment. It is in effect an actionable URL that transports metadata or keys to access metadata for the object for which the OpenURL is provided. The target of the OpenURL is the user's institutional service component (ISC). The remainder of the OpenURL transports the object's metadata. For an information service to be OpenURL aware, it needs to implement a way to know

the difference between a user with access to an ISC and one without access. For users known to have access to an ISC, information services must then provide an OpenURL for each object to be passed on to the user. OpenURL is premised on the idea that links should lead a user to appropriate resources. An ISC describes the context of the user. The SFX server from Ex Libris is an ISC that can read an OpenURL as input and take action upon it.

4. MetaLib @ the Speed of … BLUR?

MetaLib provides a single integrated environment for managing our electronic resources, whether these be abstracting and indexing databases, full-text e-journal services, CD-ROMs, library catalogues, information gateways or local collections. Through this portal we can present our users with a choice of electronic resources 'at a glance', in a way that was not previously possible using our OPAC or static web pages. If it is true that most users limit their use of electronic resources to those with which they are familiar, then MetaLib helps to address this problem by highlighting other resources too. At the heart of MetaLib is its cross-searching functionality. This allows the user to search a number of our databases simultaneously through a single interface. The results from this broadcast search can be de-duplicated and presented side-by-side for comparison. We have 13 cross-searchable resources from a range of suppliers including, for example, our OCLC databases (Psycinfo, Geobase and the MLA) and our Ebscohost ones (Academic Search Elite and Business Source Elite). We can also include our existing Dynix library catalogue in this cross-searching functionality. MetaLib also includes SFX (see Part 4), Ex Libris's context-sensitive linkage software [Walker, 2001], adding an additional range of options that provide direct links to related full-text and other electronic services [Lewis, 2002] and [http://www.aleph.co.il/MetaLib/index.html]. The company which produced the software, ExLibris, is an Israeli-based old-timer, with more than 20 years experience in servicing the automation needs of academic libraries. The reason behind developing MetaLib, in their view, was the need to offer "the best set of resources as determined by institutional and user environments and by priorities." Ensuring the availability and integrity of information resources is central to **MetaLib**'s design, along with authentication, licensing, and copyright management. **MetaLib** differs from other systems in its ability to offer users a wide range of services related to a single document. Such services include providing access to the document's full text and to entries in citation and abstract and indexing databases; checking the local holdings in a library catalog; and ordering the full text of the document from a preferred document delivery supplier. expands and integrates access to the full range of resources at a researcher's disposal. At the same time, it provides the institution with sophisticated tools to manage and administer the scholarly search environment, determine its components, and create a network of dynamic links for its users. By directing the users to the most relevant resources, **MetaLib** builds synergistic relationships among library collections, catalogs, access policies, and fiscal accountability.

MetaLib includes ResourceStore--a catalog and organizer for your library's on-line databases and resources--to guide users to the most relevant sources, and SFX, to guide users to the institution's preferred sources. With SFX, library users have access to a wide range of extended services to help them navigate through today's complex information environment. Powered by SFX, MetaLib enables librarians to guide users to the most appropriate information resources. Below are MetaLib's features as presented by ExLibris on their website:

- **Universal Gateway**, which permits simultaneous, unified broadcast searching over a large collection of data sources that are heterogeneous in structure, data syntax (for example, MARC, MAB, XML, EAD, Dublin Core, and TEI), and communication protocol (for example, Z39.50, HTTP, and ALEPH); provides both a result list for each target and a consolidated set that is merged and de-duplicated. It also compiles a unified, merged browse list, enables the user to refine queries on the basis of result sets and allows related searches based on initial search results. The Gateway provides links to data sources, typically to the records themselves, for further action

- **Discovery tool**, which translates the user's profile and query into a parallel broadcast search of distributed catalogs and databases
- **Related search service**, which locates and presents additional pertinent documents stemming from the search results
- **ResourceStore**, that provides a catalog of the institution's electronic resources—an organized, coherent, and searchable database of collections—annotated with descriptions and information such as location, relevant subject areas, and language. It Allows users to locate the resources most relevant to their fields of interest and add such resources to their personal profile, supports licensing and copyright control, and permits direct access to the data sources.
- **Multiformat platform**, which brings all formats (MARC and non-MARC) and collection types (catalogs, databases, archives, and more) to your users
- **User registration, licensing, and copyright control**, which guarantee the integrity of your institutional policies and commitments. **MetaLib** maintains a users' database as an extension to the institution's user information. The information stored in this database, along with the **MetaLib** services associated with it, enables users to maintain a personalized environment within **MetaLib**. In addition, **MetaLib** provides hooks to the institution's authentication and authorization data and policy, to ensure the appropriate use of the data sources and services by various groups of affiliated users.
- **Document availability services**, which check the availability of titles in local and remote databases and provide links to the sources
- **Merging and de-duplication**, which guarantee the most concise and intelligible presentation of search results to your users
- **SFX-powered extended services**, which provide context-sensitive dynamic links to a host of services, databases, and local holdings. Through SFX, links to extended services are dynamically generated through an analysis of the retrieved document and of the institutional and user environments. These library-defined services may be extensive and varied in nature, featuring links to resources and services such as the full text of the document, citation lookup, E-TOC services, local holdings or holdings in a union catalog, web searches and document delivery services. These extended services are configured by the institution; they are generated on the basis of an analysis of the bibliographic record and the user's affiliation; and they are context-sensitive down to the level of the field. For example, clicking the author field may bring up a link to a citation database for author lookup, whereas clicking the record's SFX button may generate links to the full text, the library holdings, or a document delivery service.
- **Personal user profile**, which offers customized options in the search environment, user interface language and display, and retention of search results
- **e-Basket**, which provides each user with an individual catalog designated for personal use. The e-Basket is where selected documents are saved and messages about new documents displayed.
- **Multilingual interface**, which accepts query words in the many languages and scripts supported by the system

Garitty et al [2002] evaluated MetaLib performance at Boston College, and reached the conclusion that technologies like MetaLib and SFX will succeed, because the "new age" libraries in which they are implemented are in a stage of connected blur (whatever that means). A world bound by physical location has now become a quaint notion. The demand in libraries for remote access to all resources all the time is just another example of this world view. The expectation that all resources will be available in electronic format is also behind this thinking. Connectivity is expected and assumed, and resources are evaluated often on the basis of how easy they are to locate and use. Students want, and often expect, to be connected to the full text of information. Lippincott and Cheverie [1999] have noted that the sequential way in which libraries make resources and services available must change and become more integrated. It is, of course, just this connectivity and

linking that has led to the success and acceptance of the World Wide Web. We need to learn from this fact, and design systems and services that respond to this user need. MetaLib contributes to this blurred world by offering students the opportunity to search a variety of resources simultaneously, such as library catalogs, indexes, e-journals, or image collections. In a blurred world, this makes sense to the user, and saves time. MetaLib is an interface that patrons can use to access resources, search across multiple resources, save searches and search results, and customize lists of resources. Librarians populate MetaLib with resources based upon what the library wants to offer.

Another evaluation of the software was done at the University of East Anglia [Lewis, 2002]. Here too, the initial feedback was mostly positive.

5. Challenges to be Addressed:

For MetaLib and SFX to work, there must be significant collaboration and a commitment to standards from the library, the ILS vendor, and database and e-journal suppliers. Caplan [2001] has commented accurately that this work is technically complex, but above all organizationally complex. The major challenges of MetaLib, according to Garitty et al [2002] were:

- time commitment by staff for ongoing maintenance and trouble-shooting;
- working with vendors to set up databases;
- staff awareness, training and incorporating MetaLib into the flow of reference and instruction work; and
- instructing students about when to use each product.
- students with more sophisticated searches are frustrated with the limited search options in MetaLib, and the short display of records does not include complete citation information.

MetaLib instruction is a challenge because the product generally works best with simple cross-database searching and those researchers with more complex searches are directed to the databases' native interface. Also, the way that records are displayed within MetaLib is different than how records display in the native interface which can be confusing to users. Finally, not all collections can be searched or linked to using MetaLib, so making sure that patrons are aware of what is not included is important.

Lewis [2002] of UEA found that:

- the major outstanding problem is how to include electronic resources that can only be accessed via ATHENS and not via IP address recognition. This is not because the database uses an alternative protocol, but because, with no other server available, the only route to access the service is via its proprietary interface and that requires ATHENS authentication up-front in the UK. Therefore a direct search cannot be done without having to login to the Web of Science using an ATHENS username and password. So to include such services, UEA will have to negotiate with vendors to change their access policies, as well as asking them for permission to cross-search.
- the other major issue is the ongoing maintenance of 'MetaLib Search' resources. Any change by the supplier to database structure or, if relevant, the proprietary interface, may affect existing configurations. This may happen without notice and put the resource concerned out of action as far as 'MetaLib Search' is concerned. People can of course still link to the resource directly, but the cross-searching functionality is temporarily lost. In our experience Ex Libris will help with trouble-shooting but it may take several days to resolve such problems.
- another limitation is the unreliability of z39.50 servers. Many database suppliers impose limits on the number of users that can access their z39.50 server at any one time or limit the number of records that can be returned. If this happens, the error messages that display in MetaLib are not very helpful to the user. This is because they do not explain why the search has

failed or indicate what the user should do to rectify the problem (e.g. narrow their search). We will also need to make users aware that cross-searching is likely to be less accurate than carrying out the same search via the proprietary interfaces. In particular, author field conversions may be far from perfect.

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