The Challenge of Integrated Access: The Hybrid Library System of the Future

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Abstract:
In this paper we discuss the role of the OPAC as a hybrid library service and of the catalogue server as a provider element in a hybrid information environment. We identify developments required in the search and retrieval capabilities of the catalogue server to operate effectively in such an environment. We look under the hybrid library bonnet at the functions and metadata needed for management of online and physical collections. Lastly, we look at the architecture needing to be supported by library systems for storage and delivery of digital collections in a hybrid information environment.

Introduction

Kinetica[1] does not offer catalogue cards as one of its resource sharing products. All but the smallest libraries now have an Integrated Library Management System. The OPAC module provides public access to the library's collections through a single interface. Library staff operate at workstations that support a range of functions enabling the acquisition, description, management and circulation of collections.

During the first half of this decade, as drawers of catalogue cards were being carried home for shopping lists, the future of the Integrated Library Management System seemed assured. Once the last retrospective conversion task had been completed; once the last visible index had been automated; once the last separate in-house system had been absorbed by the increasing functionality delivered through system upgrades: libraries could focus their attention on the delivery of information services, happy with the productivity of their collection managers and the extent to which the catalogue operated as the first point of access to the library's collections.

Digital library developments over the last five years have shaken these assumptions. Libraries have always striven to share resources through union catalogues, indexing and abstracting services and interlibrary loan, but the Internet has provided opportunities for unmediated access to distributed resources in ways not dreamt of until a few years ago. As an increasing proportion of information is made available in digital form, libraries are seeking new system solutions to the problem of providing a coherent view of the range of electronic resources available to their users. These include resources freely accessible on the Internet as well as CD-ROMs and commercial online services to which the library has subscribed on behalf of its users. In addition, many libraries have their own online collections acquired through digitisation programs or because they have assumed the role of a deposit library.

In this new digital library environment, the primacy of the catalogue in information service delivery is seen by some as under threat and with it, the backroom productivity gains promised by the integrated library management system. This anxiety is manifested by a phenomenon observable on many library discussion lists. Every few months someone posts the same basic question: "What is a digital library? How does it differ from a virtual library? Where does the traditional library fit in this new environment?"

Concept of the hybrid library

While digital libraries are by definition focused on delivery of access to collections of digital works, there is a body of informed opinion that:

> Really, the objective is to develop information systems providing access to a coherent collection of material, more and more of which will be in digital format as time goes on, and to fully exploit the opportunities that are offered by the materials that are in digital formats.... There is, in reality, a very strong continuity between traditional library roles and missions and the objectives of digital library systems (Lynch and Molina, par. 3).

[1] A national resource sharing service operated by the National Library of Australia that includes a bibliographic utility service as one of its functions.

This thinking is based on the belief that the needs of serious information seekers can only be met by providing the user with access to both electronic and traditional information resources. Any modern quality library service must endeavour to provide ready access to both types of resource. Furthermore, it should provide such access in an integrated fashion. Its search pathways should present to the user a combination of relevant electronic and traditional resources in response to searches based on author, title, subject, etc. Its browse pathways should similarly lead the user to both categories of resource.

The UK eLib Electronic Libraries program has coined the term "hybrid library" to cover services that unite the functions of the traditional library with those of electronic, digital or virtual library services:

> A hybrid library is envisaged as the bringing together of technologies from […] electronic, digital or virtual library projects which have been taking place round the world as well as in the UK's eLib programme, plus the electronic products and services already in libraries, and the historical functions of our local, physical libraries (*eLib Project Summary - Hybrid Libraries*, par. 2).

In recent work, the MODELS (MOving to Distributed Environments for Library Services) Project, a UKOLN initiative funded by the eLib program, has extended the hybrid library concept beyond the library domain, coining the phrase "hybrid information environment":

> A hybrid information environment can be described as one where an appropriate range of heterogeneous information services is presented to the user in a consistent and integrated way via a single interface. It may include local and/or remote distributed services, both print and electronic. The environment will provide some or all of the following functions: discovery, location, request, delivery and use, regardless of the domain in which objects are held. Domains may include eg libraries, archives, museums, government. There may be dynamic configuration to reflect an individual user's interests (or a group's interests). The environment will depend on open systems and standard protocols (Russell et al, *MIA Requirements Analysis Study*, par. 1).

In 1997, the National Library of Australia set up a working group to review the Library's systems environment. This working group identified similar integration issues that needed to be addressed in order for a national library to redefine itself in an emerging digital world. As a major research library, we needed a systems environment that would enable services for our own users that provided integrated access to:

- Online with physical.
- Collection with item.
- Whole with part.
- Commercial with free.
- Significant with transient.
- Local with remote.

As a national library, we needed to put systems in place to ensure development of services that would address these needs as part of the national information infrastructure.

A number of these issues arose before the development of digital libraries. For example, libraries have always faced a challenge in integrating collection-level access with item level (and analytic level) access to their resources. Similarly, the existence of commercial database and union catalogue services has for many years created a "charging discontinuity" between some of the components of resource discovery systems.

While the emergence of digital library services has increased the challenge of integration in some areas, it has created potential solutions in other areas, such as in integrating the discovery of local and remote resources, or of collection level and item level resources.

Levels of integration

The phrase “integrated access” is used widely in the context of hybrid libraries and hybrid information environments. It is worth considering the different levels of integration that might be required to achieve the objectives of the hybrid library and the development effort needed at each level.

Information maps

At the lowest level of integration, the World Wide Web now enables heterogeneous information services to be presented to a user through a simple menu-driven interface. In this model, the developer's role is to select appropriate services to list and to ensure the links to online services remain current. This is an appropriate way of building an information map to existing services where standards or interfaces are not yet in place to provide a higher level of integration; or where there is no business need for a higher level of integration. The services may be so heterogeneous that it is always appropriate to search them through a separate interface. Just because a web site search engine has the capability to search the library catalogue (or vice versa) does not necessarily mean that a combined search of the web site and catalogue is a value-added service to users. However, a decision might be taken to use the same interface to search both resources to ensure consistency in look and feel for users. In this case a more complex solution will be required.

Broker architectures

Many library OPACs include a Z39.50 client capability that can be configured to search resources other than the library catalogue. This is a simple example of a broker architecture – a set of client-based services that interface with external servers through standard protocols or application-programming interfaces (APIs). In the OPAC model, the library catalogue remains the primary target resource and may be accessed through proprietary protocols. External targets may include services like Kinetica or libraries sharing borrowing privileges. The level of functionality delivered when searching the external targets is likely to be less than when searching the library catalogue.

The MODELS Project has recently drafted an organisational and technical framework for a broker architecture – the MODELS Information Architecture (MIA). Unlike the OPAC example, the MIA does not give preference to any particular target. It assumes that “a consistent interface must be provided across multiple protocols (e.g. Z39.50, WHOIS++, LDAP) and multiple services (e.g. discover, locate, request, deliver)” (Russell et al, *MIA Logical Architecture*, par. 4). A mediator layer decides which service providers to target to deliver a particular service. For the sake of completeness, recent versions of the architecture have added a Provider layer containing the external services accessed by the system.

Broker architectures serve four main objectives:

- They provide a means of ensuring some level of semantic interoperability between existing or legacy provider systems pending the development of replacement systems that better meet local, regional or national information needs.
- They operate as an enabling technology to link essential building blocks that are best managed as distributed resources.
- They provide a single consistent user interface even when searching disparate resources.
- They enable service owners to authenticate users, track usage and deliver customised services through user profiles.

Integration of provider systems

Using broker architectures to unite legacy systems under a single user interface is a valid way of solving immediate problems. As Chris Rusbridge, director of the eLib program, points out:

> Each new system offering in this rapidly changing environment is a separate decision, and usually cannot be rejected on grounds of non-compatibility with other offerings. But there comes a time when we must review our range of systems and cry, "Enough". Time to take a stand; we must find a way to reduce the range of system interfaces, to a small number if not to one (par. 17).

However, while it is technically feasible to reduce the range of system interfaces to a small number, there are limitations to the extent of semantic integration that can be achieved through broker services. This will depend on the extent to which the provider systems:

- Support a requested function; for example proximity searching.
- Have a common understanding of the outputs required of the function; for example, the return of records containing titles beginning with a specified set of words, in alphabetic order.
- Use the same data standards; for example, MARC for resource description.
- Share business rules for the application of these standards; for example, by mapping the same data elements to a given access point, or using the same classification scheme.
- Share policies and guidelines; for example, local cataloguing rules and interpretations.

Within a given community, it will be important for stakeholders to look closely at the existing building blocks and to direct the development of content in ways that minimise the number of disparate provider systems when there is no real functional need for separate systems. Attention will need to be given, not just to the resource discovery building blocks, but also to content creation and collection building and management workflows. Delivery of an effective hybrid library service does not necessarily involve searching across heterogeneous information services. There will be occasions when a single system or a small number of systems is deemed the most efficient and effective solution.

The library catalogue which integrates access to a library's physical and online collections is a good example. Separate processes and systems have evolved within the library community for managing physical format and digital collections. This is apparent, for example, in the separation of research and development effort between digital libraries and subject gateways

on the one hand, and interlibrary loan and document delivery systems on the other. Digital collections have their own unique management and access requirements. However, if these are supported through a system separate from the integrated library management system, there is a danger that users of digital library and subject gateway services will be left ignorant of the rich collections of libraries that are not yet accessible in electronic form. This dichotomy may also cause the library catalogue to diminish in value as the first point of entry to a library's collections, and become just one of a number of resources needing to be consulted by users.

One solution to this problem is to use broker architectures to integrate access to the library catalogue and the library's digital collections through standard protocols. Another is to build a central set of indexes for resource discovery purposes. These are appropriate solutions for integrating access to disparate collections. Within a single library, however, there is a need for a collection management architecture that can provide full system support for the "hybrid library": collecting, storing, managing and delivering access to information resources regardless of format. This architecture may consist of separate modules, including a digital collection management module, which can be integrated through the use of appropriate protocols.

Similarly, in developing a subject gateway that integrates access to online resources and traditional indexing and abstracting services, it may be a better strategy to merge existing services than to invest effort in providing a single user interface that searches across a range of resources. By merging services in this context, we mean not just creating a single database for resource discovery purposes but also eliminating duplication of effort by sharing indexing and database management responsibilities. The resulting service may itself form an essential building block in a broader hybrid information environment. This kind of thinking needs to inform project funding policies.

The local hybrid library

For most libraries, the implementation of a web-accessible catalogue has been the catalyst for creating a local hybrid library. This has enabled the provision of a web interface that allows the user to access:

- The books and other physical information resources in the library's collections;
- Digital copies of physical information resources in the library's collections.
- CD-ROMs and online information resources which the library is licensed to access on behalf of its users, including full-text databases, union catalogues, indexing and abstracting services; encyclopedias and other reference tools.
- Information resources freely available on the Internet.

It is implicit in the notion of "integrated access" that all of these resources should be accessible through a common entry point. Ideally, this entry point should lead to pathways which allow the user to find relevant resources without having to search or browse separately depending on the format of the resource or whether or not it is freely available.

Ongoing importance of the catalogue

A service model is emerging for the local hybrid library that gives this role to the Library catalogue. This model recognises the value of maintaining a holistic view of the library's resources through catalogue-level descriptions as well as providing users with access to more

detailed subject- or format-based listings and links to remote resources. The aim of this model is not to enable users to undertake combined searches of the library catalogue and other database services regardless of content but to provide users with seamless views of the information resources available to library users at different levels of granularity and specialisation, with the catalogue providing the most general and the highest level view.

While libraries may showcase their digital collections through separate web interfaces, the modern OPAC also enables digital copies of physical collection items to be directly accessible through links in the catalogue. A range of purpose-built applications now exist, like Monash University Library's Electronic Resources Directory, that list electronic indexes and databases available to the library's users. Similarly, many libraries are constructing links to Internet resources in given subject areas as a value-added service to their users or promoting the use of particular gateway services. A true hybrid library service needs to break down the distinction between "Our Catalogue" and "Electronic Resources" inherent in this approach. Ideally, electronic resources should appear in result sets when a user does a subject search of the library's catalogue. Users need to be able to discover physical as well as electronic indexes when venturing beyond the catalogue.

Figure 1: NLA Research & Information Services Home Page

Our IRIS as an example

The National Library of Australia has based the development of its new Integrated Research and Information Services (IRIS) on such a model [Figure 1]. (While we call the service IRIS

in-house, it is not branded separately from the rest of the National Library web site.) IRIS differs from the base model in that, where the Library has catalogued a significant Australian online resource, it has also undertaken to archive a copy for future access. An important principle behind the new service is the integration of resources regardless of format at every level.

IRIS includes an Indexes & Databases service that lists both physical and electronic resources accessible to the Library's users, with the local call number for physical resources. [Figure 2].

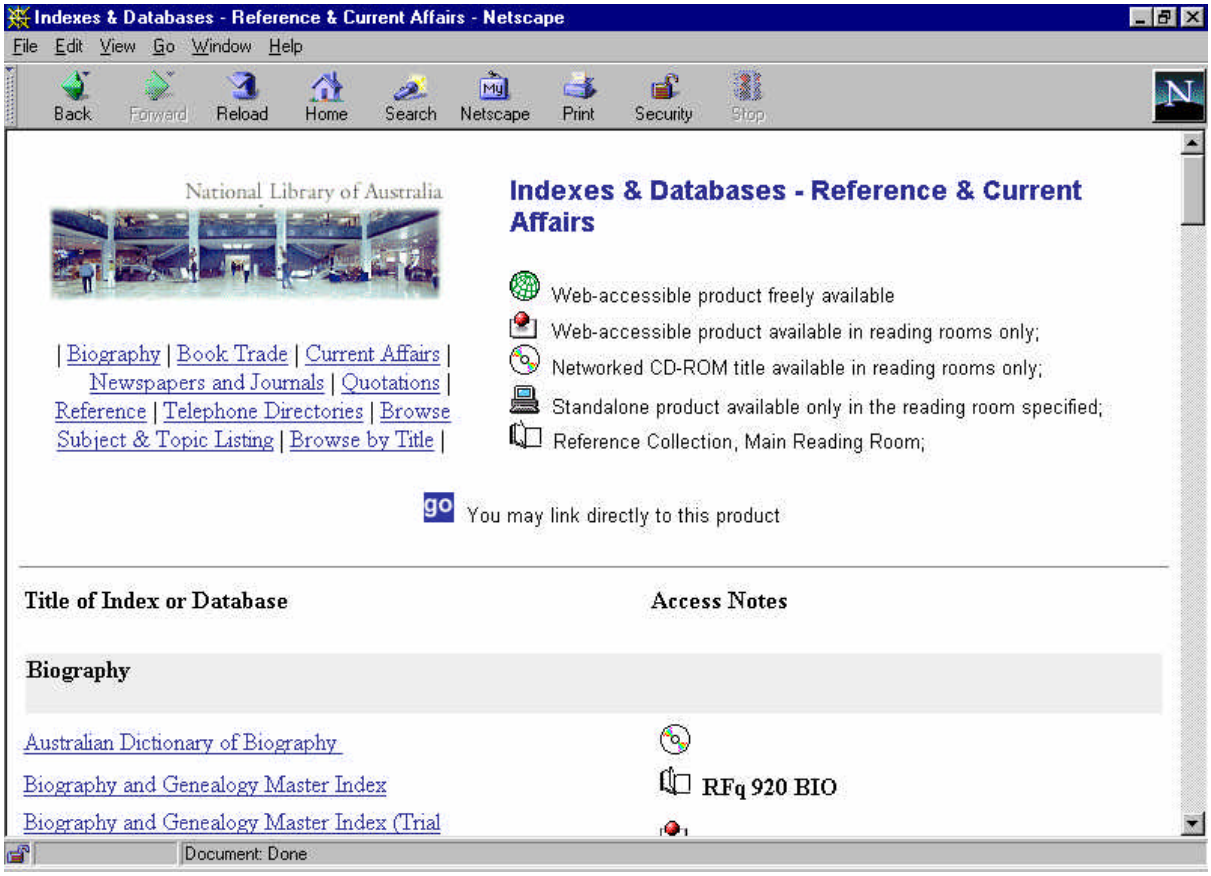

Figure 2: Indexes & Databases – Business & Commerce page (external view)

IRIS has also been designed to place the Library's own collections in a national and global context. There are links from the main entry page [Figure 1] to the National Bibliographic Database (via Kinetica Web), to the Australian Libraries Gateway, to other collections in Australia and to Internet resources. Each of the Library's special collections – maps, manuscripts, music – has its own virtual reading room with links appropriate to the special collection format, even when, as with music, there is no corresponding physical reading room. For each format, the catalogue continues to operate as the first point of access to the collections, in many cases via a format-based subset. At this level, the most important national and global links are to directories of collections and union lists of materials in the same format, where these exist in print or electronic form.

IRIS does not yet meet the criteria for a fully integrated hybrid information environment. User authentication for subscription-based services is limited to a simple domain check. There is no sharing of data between the catalogue and the Indexes & Databases service. Most

of the online resources are not catalogued because of the workload involved to maintain the currency of the data. (In practice, this has just transferred the workload from the Technical Services to the Information Services area and encouraged the use of a simpler data format and the development of separate provider systems.)

Beyond the Catalogue and the Indexes & Database service, IRIS achieves its hybrid library goals mainly at the information map level. Much work still remains to be done to define and develop the appropriate regional and national provider systems. Until this work is well advanced, services like IRIS will only be able partially to address the third objective of broker architectures defined above: that is, to provide a single consistent user interface even when searching disparate resources.

Nevertheless, IRIS is already a hybrid library in the sense that the hybrid library ethos informs all aspects of the IRIS service model. By adopting a model where the catalogue is the first point of entry to the Library's collections, we have committed ourselves to a long-term process of development of the integrated library management system to provide "under-the-bonnet" support for the hybrid library concept.

Beyond the local level

While services like IRIS are providing a first step, at the local level, towards a hybrid library service, a more difficult challenge lies in extending hybrid library services to support users at a regional or national level. Australia is fortunate in having three important national resource sharing services already in place: the National Bibliographic Database, the Australian Libraries Gateway; and the Register of Australian Archives and Manuscripts.

In addition, Australia has a well-established tradition of library cooperation manifested in a national interlibrary loan network that is now based on open standards. Technologies are in place that enable the delivery, in digital form, information resources from remote library collections using document delivery services such as Ariel. In this case the key difference to the user between a digital service based on a digital collection, and one based on a traditional collection, is the length of the delay that occurs before the collection item is delivered.

The challenge lies in developing the infrastructure to integrate access to physical and online resources:

- Within a given group of libraries at other than a national level.
- Within a given subject area (Australian literature, geography).
- Within a given format (pictures, maps).
- Across collecting agencies – museums, libraries and archives.

As with the local hybrid library, models for regional and national services need to be sought in the provision of seamless views of the information resources available at different levels of granularity and specialisation.

The local hybrid library system has a larger role to play in regional or national hybrid library services. For instance, the full extent of the library's holdings needs to be represented in union catalogues. The library's digital collections need to be accessible as part of regional or national digital library services. Significant holdings in given subject areas or formats need to be declared in directories, union lists, subject gateways, multimedia publications and online exhibitions.

In December 1998 the National Library of Australia issued an Information Paper as part of its Digital Services Project. Chapter 1 of this paper outlines the Library's overall vision for digital service delivery. The section on the National Bibliographic Database (Australia's national union catalogue) states:

> The Library will develop the capacity of the National Bibliographic Database to serve as a gateway to the distributed national collection by encouraging contributors to include links in catalogue descriptions to electronic publications and to digital copies of items they have created to enhance access to their own collections (1.4.4.1, par. 4).

This differs from the approach of OCLC's CORC (Cooperative Online Resource Catalog) Project. The aim of the CORC Project is to help libraries with link selection, link maintenance, resource descriptions and the creation of pages providing access to publicly available Web resources. This assumes that there will be separate provider systems and possibly separate data standards for describing online and physical resources at the union catalogue level. While such systems can be united through broker architectures, a deeper level of integration can be achieved if the underlying system operates as a hybrid library in its own right. In addition, it should be possible to exploit existing resource sharing mechanisms to develop and deliver a range of targeted hybrid library services at the local library level.

Technical issues and directions

Librarians were right to be anxious about the future of the library catalogue in one area. It is unlikely that the OPAC module of the integrated library management system will predominate as the client software deployed in broker architectures. The Z39.50 server will be as important as the OPAC in enabling the library catalogue to function as a provider element in a hybrid information environment. For this to happen, work is needed to improve the interoperability of current systems. The issue lies not with the Z39.50 standard itself but with the need for a profile defining the levels of conformance required to ensure interoperability. A profile specifies the use of a particular standard, or group of standards, to support a particular application, function, community *or* environment.

Inadequacies of current implementations

To date the Z39.50 capability of integrated library management systems has been used mainly to provide a web/ Z39.50 gateway to the catalogue for remote users and to enable searching of other systems for copy cataloguing purposes. The main development effort has been directed to PC- or Java-based clients. The functionality offered to users via Z39.50 has been a subset of that offered through other OPAC products.

Over the last two-three years research effort has been directed to the deployment of Z39.50 in order to deliver virtual union catalogue services. Examples include the "Clumps" projects, the ONE OPAC Network in Europe Project, the National Library of Canada's Virtual Canadian Union Catalogue Project and, here in Australia, the ZedWeb Project. These projects highlighted the extent to which implementers had interpreted the Z39.50 standard differently.

The Bath Profile

In August 1999 a meeting was held in Bath, UK to draft an international library system profile that would address this issue. The Bath Profile, building on the work of earlier profiling projects, defines a range of author, title, subject, keyword, date of publication and standard identifier searches needing to be supported, the exact combination of attributes required to specify each search type and the expected behaviours.

Library catalogues are good at enabling users to browse structured indexes and do exact match and “first in field” searches. They also provide users with a basic repertoire of keyword searches. This is the range of functionality addressed by the Bath Profile for search and retrieval of library catalogues. In addition the Bath Profile defines levels of conformance for cross-domain searching. For the library catalogue to be searched in conjunction with non-MARC based systems, a quite different set of searches needs to be supported. The main differences are:

- The requirement to support the exchange records in Dublin Core format marked up using an XML Document Type Definition.
- The requirement to support proximity searching (as against “first in field” and exact match).

Dublin Core

One potential barrier to cross-domain searching has been the divergence of metadata standards between the world of traditional publications (based mainly on the AACR2 and MARC standards) and the world of digital publications (which may be based on Dublin Core or other non-MARC standards). The Dublin Core metadata standard has been developed during the past few years, with two main purposes. One has been to support “simple resource discovery” for digital collections. The second has been to provide a kind of “lingua franca”, with the potential to integrate access to library, museum and archive collections as well as to the wider universe of Web based resources.

As well as being a “lingua franca” across the sectors, the Dublin Core standard may be useful in supporting search access across various collection levels. For example, the experience of the library and information industry has exhibited a divergence of standards between those used to describe and support access to the whole item, on the one hand, and those used to describe and support access to part of the item, on the other. This traditional dichotomy between the cataloguing community and the abstracting and indexing community has the potential to create access barriers. The Dublin Core standard will assist in bridging these barriers, by providing a basic set of descriptive elements to which the cataloguing and indexing data elements can be mapped.

Convergence of systems

Over the next few years it will be important for the search and retrieval functionality supported by digital library and traditional library systems to converge. Search engine products have refined the art of developing simple user interfaces that use term weighting and relevance ranking to control results while supporting a full Boolean search syntax for advanced users. However, they are less good at enabling users to browse structured indexes and do exact match and "first-in-field" searches. As more Dublin Core-based repositories are developed this capability will be needed to exploit the indexing effort where thesauri have been used or an attempt has been made to normalise the form of names.

In addition, until recently, search engine vendors have tended to ignore the need for a standard search and retrieval protocol like Z39.50, mainly because this has not been an expressed requirement in procurement exercises. During 1999, the National Library of Australia issued a Request for Quotation for a Metadata Repository and Search System with Z39.50 support as a mandatory requirement. This requirement reduced the range of eligible products to a small number. One of the first services to be migrated to the selected system will be the Register of Australian Archives and Manuscripts (RAAM). This will make RAAM immediately accessible as a building block in Z39.50-based gateway services such as Kinetica Web.

Multiple Z39.50 targets

The library catalogue is not necessarily a single Z39.50 target. Most library systems support a logical data model consisting of at least three separate targets: a bibliographic database, an authority database and a holdings database. Z39.50 profiles are currently in the final stages of development for searching thesauri and holdings information. The Bath Profile includes a functional area for search and retrieval of holdings that will be finalised shortly and will include a new functional area for thesauri in a future version. The viability of the virtual union catalogue will depend on support by Z39.50 implementations for a logical holdings database with its own attribute set. Opportunities for supporting distributed thesauri in searching or cataloguing will depend on support for a logical thesaurus database. In addition, libraries with strong special collections or subject strengths may wish to slice the bibliographic database itself into separate Z39.50 targets each with its own set of searches. This is how the National Library of Australia might ultimately deliver its Indexes & Database and Reference Shelf services, for instance.

Multiple Z39.50 profiles

As another example of the need for separate logical views of the catalogue, the National Library of Australia is currently exploring ways of making its map collection searchable as a node of the Australian Spatial Data Directory (ASDD). The most likely solution will be to download the records from the catalogue to the library's new metadata repository and search system. Our preferred strategy when the integrated library management system can support it, however, is to define the map subset of the catalogue as a Z39.50 target. This will enable it to be accessed by external systems and also by a purpose-built interface for our own users that exploits spatial data in records to provide geographical navigation capabilities. For this to be possible, the Z39.50 server will need to support not only multiple Z39.50 targets but also the search and retrieval behaviours defined in the Z39.50 Application Profile for Geospatial Metadata or "GEO" (Nebert).

Convergence of profiles

Within the Z39.50 community, a need has been identified for profiling groups to share outcomes. The developers of the CIMI Profile (the Z39.50 Application profile for Cultural heritage Information) plan to include a reference to the cross-domain functional area of the Bath Profile rather than developing a similar set of requirements within the CIMI Profile itself.

Perhaps even more importantly, there is now recognition that library systems need to support multiple protocols in order to deliver a full range of library functions in a distributed environment. The ILL Profile Implementers' Group (IPIG) and the Z39.50 Implementers' Group (ZIG) held their meetings for the first time back-to-back in Stockholm in August 1999.

Members of IPIG going on to attend the ZIG Meeting were able to provide valuable feedback on the work of the IPIG and a direction for future meetings of the ZIG was agreed that would address cross-protocol implementation issues.

In the hybrid library, search and retrieval workflows may result in direct access to electronic resources or access to functions for locating, requesting and obtaining a copy of an item. In either case, tests may need to be made of the user's right to access the material and any access conditions that apply. Profiles will need to be developed that address the need for user interfaces to support a range of contiguous functions through the most appropriate underlying protocol. This may be Z39.50 for search and retrieval of bibliographic and holdings information, ISO 10160-1 for interlibrary loan or X.500 for identifying lending policies and access conditions.

Under the hybrid library bonnet

In August 1999 the National Library of Australia released a Request for Tender for a Digital Collection Management System. Through this Request for Tender, the Library hopes to acquire a system to support preservation of and access to the Library's permanent archive of on-line electronic publications and to the Library's collection of digital surrogates of pictorial items. Once implemented it is hoped that the system can also be deployed to support the Library's other digital collections as well as physical format items in the Library's collections that require special curatorial control.

Inadequacies of current systems

Integrated library management systems currently provide a good level of support for managing printed collections but few yet deliver full support for materials such as manuscripts, rare books, maps, sound recordings or pictorial materials. These collections have special curatorial requirements for recording the provenance and condition of items, their preservation history, intellectual property rights and conditions of access that are usually still met through a range of separate manual and automated systems. Digital collections pose similar problems and need similar management solutions, but few digitisation projects have yet really addressed the ongoing collection management issues. Metadata standards in this area are only just beginning to emerge and are expected to take several years to evolve.

Because of this the Library expects to maintain a separate integrated library management system in the short term, with the Digital Collection Management System operating as a logical extension of this system through standard interfaces for the exchange of data. To operate effectively as a hybrid library system the integrated library management system will need to be developed to support an extended data model that enables descriptions of objects at the collection, item and sub-item levels. The current acquisition and cataloguing functions will need to be supplemented by functions supporting selection, negotiation, capture, rights management and preservation management processes.

Metadata development

As part of the Request for Tender for its Digital Collection Management System, the National Library included a logical data model for the Object Management System [Figure 3]. This is based on a model originally developed for the Library's PANDORA (Preserving and Accessing Networked DOcumentary Resources of Australia) Archive.

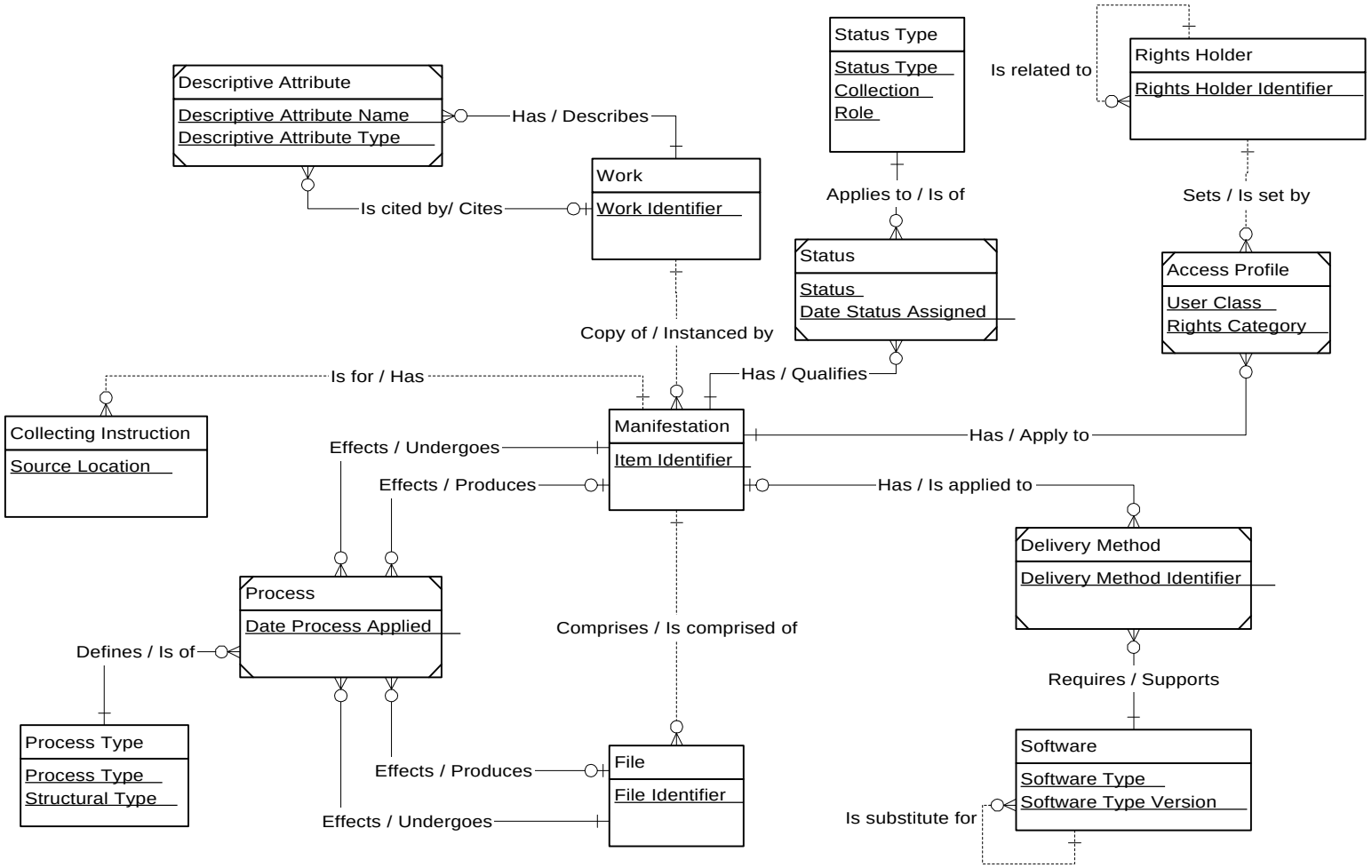

Figure 3: Digital Collection Management System. Logical Data Model

The PANDORA Archive is dedicated to preservation of and long term access to Australian online publications of national significance. During 1999, the Library undertook to expand the PANDORA Data Model to cover digitally reformatted collections as well as online resources. Work on the new data model was informed by a separate process undertaken by the Library to expand the Research Library Group's work on preservation metadata for digitally reformatted materials to include online resources. To our knowledge, this is the first time an attempt has been made to combine the data requirements for managing resources "born digital" and digital surrogates in a single model.

For integrated library management systems fully to support the management of digital collections they will need to be developed to support such a data model. Alternatively, they must be able to interface through standard protocols with systems that have this level of support.

Storage and delivery of digital objects

Many digital library projects and vendor systems use a single system to manage both the resource discovery process and the storage and delivery of the digital objects. This is an appropriate architecture when a single agency is responsible for both the digital collection and the resource discovery service. In a hybrid information environment separate provider systems may be used for resource discovery and digital object delivery. For example, when the National Library of Australia digitises a rare map, a link to the digitised copy is included in the catalogue record that is contributed to the National Bibliographic Database. Users of the National Bibliographic Database are able to discover the digitised copy and view it online without the National Bibliographic Database needing to store a copy. The Kinetica Web client does not need to know anything about the processes the user will invoke to access the map.

In the future, it should be possible to link to the digital copy of the map on the National Library's server from an online exhibition, thesis, research paper or multimedia publication without duplicating the digital object on another system. This is already technically possible but full acceptance of such an architecture will depend on:

- The use of persistent identifiers for digital objects.
- A technical infrastructure supporting the resolution of persistent identifiers.
- A content infrastructure where the owner of the digital object guarantees its ongoing accessibility through the application of appropriate migration or emulation strategies.
- Common approaches to the storage and delivery of digital objects that encapsulate methods of access with the object.

The Digital Library Federation's Making of America II Testbed Project is currently developing a model for digital library objects, based on an object-oriented approach to digital library construction. The project asks the question "how can we create digital library services that interoperate in an integrated manner across multiple distributed repositories. The outcomes of this research should be digital object definitions for different classes of materials; for example: photographs consisting of a single digitised image, photograph albums consisting of multiple images and diaries made up of both page images and textual transcriptions. The definitions will include the digital content itself, metadata and methods for accessing the objects. The model depends on resource discovery at collection level using descriptive metadata standards like MARC as well as electronic finding aids based on standards such as the Encoded Archival Description (EAD).

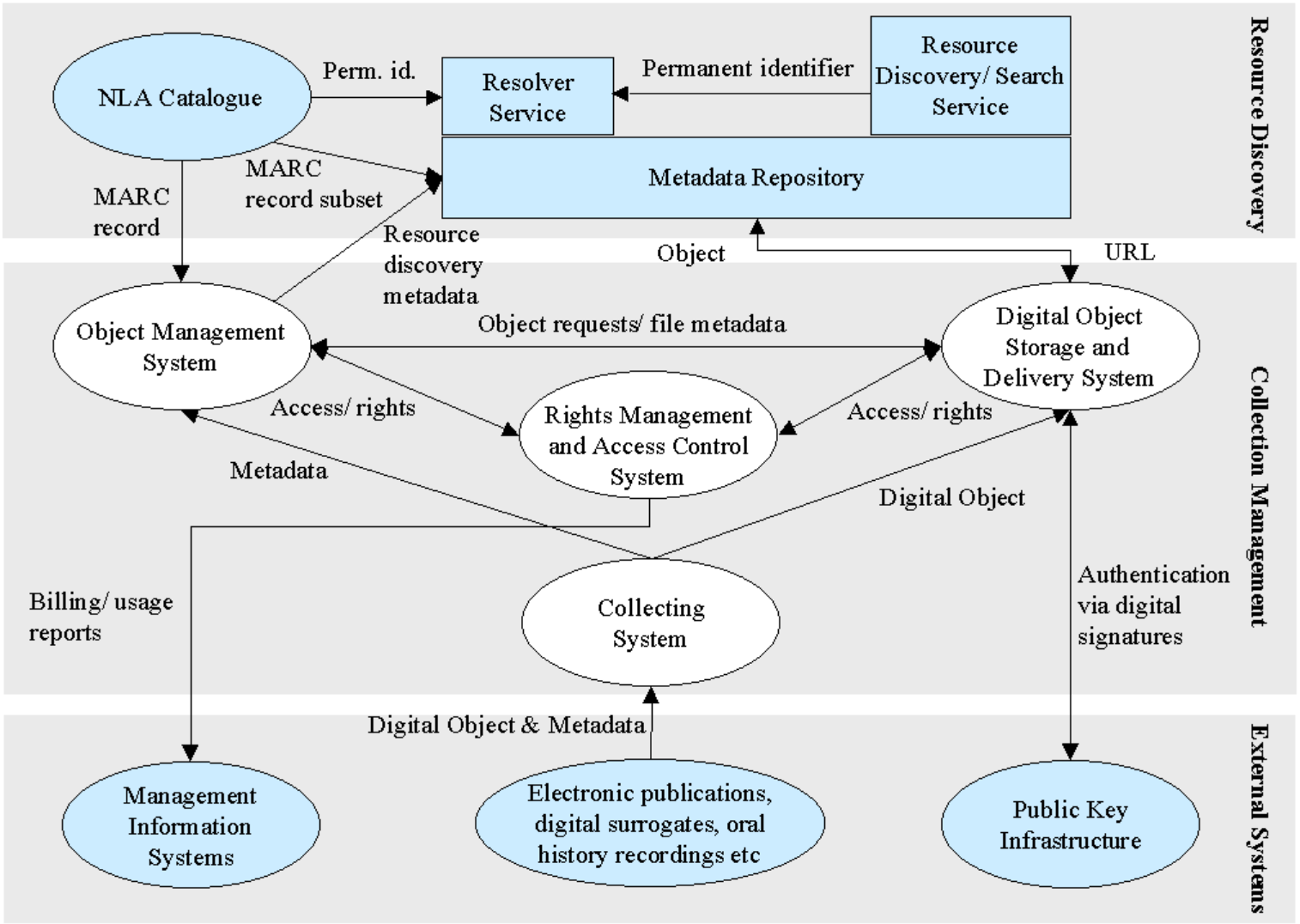

Figure 4: NLA's Digital Collection Management System - Logical Systems Architecture

In the Request for Tender for its Digital Collection Management System, the National Library has defined a Logical Systems Architecture that is based on similar principles [Figure 4]. In this model, the Digital Object Storage and Delivery System provides for storage and delivery of the Library's digital objects using methods and navigation paths provided by metadata about the objects stored in the Object Management System. The Rights Management and Access Control System manages external user access where conditions apply. The resource discovery services illustrated in the top section of the diagram lie outside the scope of the Digital Collection Management System itself because they may be owned and managed by agencies other than the National Library.

Conclusion

The integrated library management system has an important role to play in the delivery of hybrid library services. There is an ongoing requirement for development of the catalogue as a provider system. In addition, there is still a role for the OPAC as a means of delivering access to the specialised functions needing to be supported at the local library level. However there will need to be a shift in development priorities from the OPAC to the Z39.50 server for the catalogue to realise its full potential in a larger hybrid information environment.

Efforts to develop the integrated library management system to manage special collections need to be continued and extended to digital collections. Standards in this area are still under development. It will be important to ensure that short-term gains are made recognising the need for convergence with standards as these evolve. Systems designed to support both the discovery of digital objects and their storage and delivery should be developed with recognition that, in a hybrid information environment, digital objects may be linked to from a variety of external resource discovery systems.

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