

Repository Management and Implementation

A White Paper for alt-i-lab 2004

**Prepared on behalf of
DEST (Australia) and JISC-CETIS (UK)**

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" If we cannot sustain the repositories we create we will retard our progress towards providing access to digital materials. If collections on which individuals have worked hard are forgotten or neglected, as some already seem to be, we will end up recreating, rediscovering and re-describing materials many times over"

Colin Holden, 2003

1 Aims, audience and assumptions

This white paper aims to present a succinct overview of the current environment or state-of-play (as opposed to the state-of-the-art) in the area of Repository Management and Implementation. The intended audience for this white paper is the global e-learning community and the issues raised are likely to be of key interest to policy makers, strategists and funding agencies. While this paper is written primarily from a higher education perspective the issues that are identified here are of direct relevance to the wider learning, education and training community.

As there is still a considerable degree of ambiguity regarding what constitutes a "repository", the term is used throughout this paper in a very broad, generic sense. For example, the term will imply different things to an administrator of an institutional research archive and to a teacher building a collection of learning resources. The issues highlighted here relate to repositories in every sense of the word, regardless of the domain they serve and whether they are identified as learning object repositories, metadata repositories, institutional repositories, personal repositories, peer to peer repositories, digital repositories, digital libraries, some implementations of e-portfolios, etc.

2 Starting point

In early 2003, following the publication of the IMS Digital Repositories Interoperability (DRI) Specification, the IMS Global Learning Consortium (IMS) and the Coalition for Networked Information (CNI) took an important step towards developing ongoing dialog and bridging the conceptual divide between the library information services and 'learning' communities by publishing the first draft of the white paper "Interoperability Between Library Information Services and Learning Environments – Bridging the Gaps." This white paper stimulated considerable discussion and debate at Alt-i-Lab 2003 and beyond and many of the points raised have been incorporated into the final paper published in May 2004.

The IMS / CNI white paper presents a high level mapping of potential interactions between library information services and learning environments and attempts to identify functional requirements and common services that are mutual to both domains. These tasks are primarily approached from a technical perspective articulated by the IMS DRI Specification. The emphasis of the paper is on "standards, architectural models (and) interfaces" (McLean and Lynch, 2004, p1) and the primary focus is on addressing technical matters such as search services, modelling objects and activities, identifiers, metadata, access management, rights management, portal standards and people information. However the authors acknowledge that there are many questions relating to culture, politics and practice that remain to be addressed and stress that the drive towards technical interoperability must be accompanied by a reassessment of these broader issues. In addition, the authors call for an "analysis of the current state of play" (*ibid*, p6) and a

“conceptual shift away from traditional systems architecture” (*ibid*, p14) and towards flexible frameworks defined by services.

This white paper attempts to respond to this call by presenting an overview of the current environment from a conceptual and strategic perspective and outlining the relevance of recent developments in service oriented architectures and frameworks to managers, implementers and users of repositories.

2.1 The current environment

It is fair to say that repositories have a remarkably high profile in learning, education and training communities at this particular point in time. In the twelve months since the publication of the IMS DRI specification and the first draft of the IMS / CNI white paper there has been an explosion of interest in repositories across all sectors of the global educational community. Awareness is growing exponentially as a huge range of white papers, electronic publications, articles in the scholarly press, conferences and events and consortia activity attempt to articulate the role of repositories in addressing the requirements of their own particular communities, and increasingly those of learning, education and training. In addition, a plethora of projects and programmes are attempting to develop technical solutions and to implement repositories in real educational environments¹.

While the IMS / CNI white paper focused on the technical relationship between library information services and learning environments many recent initiatives have moved on from this generalised position to address the challenges of integrating repositories with a wider range of environments, systems and services across domains and sectors. A significant example of this cross-domain communication is the increasing engagement of the e-Sciences and Grid communities within the information, learning, education and training domains. This has been accompanied by the recognition that the benefits of interoperability and integration between distributed systems and services within a domain also applies across domains.

In the process of modelling their infrastructure each of the communities above has identified a layer of services and applications that either require common solutions across domains (e.g., authentication), or where there appears to be some level of commonality in requirements across one or more domains. Services over repositories are such an area. It is too soon to ascertain to what extent it is possible to define common repository services across multiple domains, however potential common solutions include: collaboration between domains to agree specifications/standards for repository services; adoption of specifications/standards developed in one domain which are then extended or profiled by the other domains; and the adoption of specifications/standards developed by external communities. What is significant is that these multiple domains now recognise their common interests and interaction between the domains is now taking place.

It is likewise not clear to what extent middleware activities will impact specifically on repository services, or if the focus of middleware developments will be on supporting infrastructure such as authentication and media delivery technologies. However it is clear that whether or not common approaches to repository services are found, there will be a need for services that federate across domain repositories.

¹ See Section 6 – Resources for examples of documents and projects

Although there has been substantial progress in implementing repositories in real world learning, education and training environments, a considerable degree of confusion still remains. While end users and some administrators may be aware that their organisation could benefit from developing a repository they may not be fully cognisant of the functionality offered by different "types" of repositories, the different repository services that can be offered over a repository, and how this functionality can be exploited. In short teachers, trainers and managers may have heard about repositories but they are still unclear about what they are and how they can be used and embedded in their practice. In addition to this lack of practical clarity it appears that the educational community is viewing the task of managing its resources with an increasing degree of trepidation. It is noticeable that several of the papers, publications and projects referenced in this paper introduce the resource management problem space by focusing on the proliferation of institutional and organisational assets. Not only is the quantity of resources growing exponentially but the range of materials is also escalating and there is an implicit assumption that all these assets require management and preservation. While this is partially true, greater consideration needs to be given to the degree of management and preservation that different types and manifestations of resources require and the different repository functionality that can meet these requirements.

This ambiguity in relation to repositories and resource management confirms McLean and Lynch's assertion that while there has been, and continues to be, considerable progress within the technical domain, there are many significant conceptual and strategic issues that need to be addressed if repositories are to become embedded in educational practice. A brief overview of these issues is presented below.

3 Cultural and conceptual issues

3.1 What is a repository anyway?

There is still considerable confusion across education, training, research and information management communities regarding what actually constitutes a repository, given the wide utility of the concept. Many HE practitioners implicitly equate digital repositories with learning object repositories, which may contain both content and metadata or may only contain metadata which references external resources. The term "referatory" has been coined in recent years to identify repositories that contain metadata alone. However, such referatories still function as repositories and should be regarded as such for the purposes of this paper.

Peer-to-peer repositories have a relatively high profile at present with some communities arguing that they offer a more egalitarian, user centred alternative to centralised curatorial institutional repositories. In addition, wikis and blogs are growing in prominence in educational domains and there is increasing debate as to whether it is appropriate to identify knowledge management tools of this kind as "repositories". The DIDET project is using a wiki as one of their central knowledge management tools for example. Some communities regard ePortfolios as personal repositories while others see them as user-controlled stores of 'works-in-progress' that can be packaged in customized ways to meet various presentation requirements.

From an entirely different perspective the e-Science and research communities are primarily concerned with large and highly dimensioned data sets, geographically

distributed and stored using a variety of repository technologies. Although many of the issues associated with managing data sets are unique to these communities, many of the issues identified are also common to the educational community. Persistence of access and digital preservation are two key issues currently preoccupying the research community that are also of considerable significance to the wider educational domain.

Key Questions

- How do digital learning resource repositories relate to other institutional repositories including digital libraries?
- Are wikis, blogs and ePortfolios repositories? What does this imply for repository infrastructure and services in both the functional and technical sense?
- What are the distinguishing features of content management systems, learning content management systems (LCMS) etc? Are LCMS different from other types of repositories?
- How do peer-to-peer repository architectures relate to other distributed and federated systems? What are the real differences, if any?
- How can we assist implementers and developers of repository management software to distinguish between repositories, repository interfaces and different levels of repository services?

3.2 Incentives for using repositories

While information management professionals might be aware of the strategic benefits of implementing repositories, educational practitioners are still inclined to ask why should they use repositories in the first place? What will they do to facilitate their current practice? The “Why” question is perhaps one of the most significant problems relating to the use of repositories that the learning technology community has failed to adequately address. In theory this question is simple to answer; repositories facilitate more efficient storage and management of resources, they enable users to share their resources and to discover resources shared by others. In practice practitioners argue that they are capable of managing their own resources on their own desks and desktops. In addition they ask why would they want to share their resources anyway, and even if they wanted to share, where would they find the time to create all that metadata ...and isn't this the library's job anyway?

Quality assurance is another significant issue that needs to be addressed. Although practitioners may initially be enthusiastic about the prospect of having access to resources shared by others they also tend to state that they would only use materials that are quality controlled and peer reviewed, regardless of whether traditional peer review mechanisms are appropriate for different types of digital assets. The fact remains however that the issue of quality assurance still needs to be resolved as practitioners are understandably reluctant to use resources of doubtful provenance and substance.

Key Questions

- How can we encourage educational practitioners to manage their resources more effectively?
- What are the incentives for using repositories?

- How can we address the issue of quality assurance, particularly in decentralised user controlled repositories?

3.3 What does it mean to publish?

Many of the apparent objections that arise in response to the “Why” question relate to conceptual interpretations of what it means to publish. In academic contexts publication tends to carry formal connotations across domain boundaries and educational resources are not published lightly. If submitting teaching or training resources to an institutional repository equates to publication teachers may be unwilling to share draft quality materials that could impact on their academic or professional standing, unless they are given adequate control over the resources they “own” and the process of publication. In addition, where is the incentive for teachers to apparently give away resources in which they have invested a considerable degree of their professional educational capacity when they could be formally published instead?

One of the perceived advantages of peer-to-peer repositories and shared workspaces, as opposed to institutional repositories or digital libraries, is that they appear to offer a less formal alternative to publication. Adding a resource to a shared workspace or a peer client residing on your desktop may seem less like publication than submitting a resource to an institutional repository. Educational practitioners are likely to be more willing to share resources within their own communities of practice.

Hybrid systems provide personal spaces within an institutional repository that allows users to control the sharing of resources in that space. Resources can then be transferred to the institutional repository space on meeting agreed requirements.

Key Questions

- What does the concept of publication mean in relation to different types of educational materials and within different learning, education, training and research communities?

3.4 Resource lifecycle

A consequence of the changing nature of publication is the need to reconsider the established view of resource lifecycles. Stewardship of resources has traditionally been regarded as primarily involving library and archive functions, with the extent to which a resource was managed based on a judgement of the value of the resource (often determined by its publication status) and the length of time for that it retained its value. As digital learning resources of all types proliferate and evolve it is necessary to review the need for related information management functions such as access, archiving, preservation and disposal.

A key concept in lifecycle management for digital objects is **persistence**. The National Library of Australia (NLA) has developed a widely adopted categorisation, originally for web materials, that is can be usefully applied to the range of digital resources. These categories are independent of the publishing regime:

“Resource categories which need persistent access include:

- information which is likely to be of long term value;
- resources which you know will be linked to by other resources;

- resources that are bookmarked by many people.”²

Persistent resources may be either static or dynamic. Consequently there are different lifecycle issues, particularly in relation to archiving and destruction strategies to be considered: a static resource is never modified, whilst a dynamic resource can undergo modification by deletion or insertion of content. This concept of dynamism is inherent in the ‘philosophy’, if not the current actuality of reusable learning resources.

The NLA uses the term **ephemeral** to refer to persistent dynamic resources as those that “are not likely to be cited in other resources, but are frequently bookmarked for regular use and users want the latest version” e.g. “what’s new”³. The remaining persistent objects are treated as **archival** resources. The archiving, preservation and destruction policies for these resources will depend on the nature of the object (e.g., there may be legal, usage or custodial requirements for long term preservation in addition to a determination about “usefulness”) and will be a matter of judgement.

In this context persistence means a digital object can be accessed over time. The NLA takes a three-pronged approach to achieving persistence:

- “Maintaining the archival information package: the byte-stream which constitutes the digital object and the information needed to present it as a meaningful reproduction of the originally presented digital object;
- Maintaining means of accessing an acceptable presentation of the digital object; and
- Maintaining the ability to locate the digital object reliably.”

Institutions and organisations need to develop lifecycle management policies for “persistent archival” resources, and mechanisms for ensuring persistence. At the same time institutions and organisations must be aware that it may not be possible to determine whether a resource will become a “persistent archival” resource at the time of creation and be prepared for the implications of evolution to this status.

Whatever one’s view of “publication” and “persistence”, institutional repositories and their management strategies will need to deal with a mixture of both “raw” and “processed” materials, including datasets, “un”published yet persistent material, dynamic resources, preprints, scholarly publications, resource lists and e-portfolios.

The implications of resource lifecycle for quality assurance and rights management policies also need to be considered. Resources will require variable degrees of quality assurance and different points in the lifecycle. New models of ownership, the trade in rights, and rights in aggregated or modified objects will require management over the life of the object.

The concept of some form of centralised control is implicit in many “traditional” information environments. Discussions surrounding user controlled, decentralised environments (e.g., peer-to-peer, wikis, ePortfolios) and centralised authority

² National Library of Australia, Managing Web Resources for Persistent Access
<http://www.nla.gov.au/guidelines/persistence.html>

³ In some educational communities the term “ephemeral” is used to refer to the outputs of teaching and learning that have not undergone some kind of formal publication procedure – not a particularly helpful definition on which to base discussion of lifecycle management for digital learning resources

controlled (e.g., institutional repositories, digital libraries) systems are becoming increasingly polarised. In reality information resources are likely to pass through a variety of repositories, which are controlled and managed by a range of individuals and agencies, throughout their lifecycle. Moreover, many information resources will be held in some kind of partnership involving trusted network nodes (or authorities) and end-users.

Key Questions

- At what lifecycle point(s) is it necessary for resources to become persistent?
- What does “persistent” mean in relation to digital resources and in the context of distributed environments?
- For resources to become persistent they require globally unique actionable identifiers. At what point in their lifecycle should identifiers be allocated to resources?
- What are institutions’ and organisations’ requirements and obligations for preserving and archiving digital resources?
- Do institutions and organisations have a legislated obligation to archive teaching, learning and research resources?
- What are the implications for non-repudiation when a resource must remain auditable over time – e.g., for legal purposes?
- What types of repository services are required to accommodate resources as they evolve?
- What kinds of QA strategies are required as resources evolve?
- Who is responsible for managing and controlling access to resources at each stage of their lifecycle?

4 Policy and strategy issues

4.1 Ownership and management of educational assets

One of the most significant strategic challenges currently facing organisations and institutions is how to coordinate the ownership and management of their educational and information assets, including scholarly publications, research data and the outputs of teaching and learning. While most organisations and institutions may have clear copyright and IPR policies relating to published materials, many educational practitioners tend to regard themselves, rather than their institutions or organisations, as the owners of their teaching resources. If “publication” of these teaching and learning resources in centralised repositories results in the institution or organisation tacitly assuming ownership of these resources this may explain many practitioners’ reluctance to submit their resources to centralised repositories.

Historically, educational resources have existed within an owner centred culture with professional groups or individuals administering the key tasks of ownership, acquisition, management and access control. However digital assets are, by their nature, situated within a more user centred culture where ownership, management and access control may be distributed across institutional roles and communities. Within such a user centred culture Lynch has argued strongly that gate-keeping policies, particularly those based on traditional quality control mechanisms such as peer review are often counterproductive (Lynch, 2003). The growing popularity of peer-to-peer repository systems has already been noted and it can be argued that these decentralised self-organising systems are better suited to facilitating a user

centred approach to resource management. However questions remain as to how digital resources can be managed at the organisational or institutional level using distributed user centred repositories. What mechanism will give authors maximum control over what they choose to share or publish and whom they choose to share it with, whilst allowing an organisation to maintain a coherent overview of its core assets?

In addition to the debate surrounding owner and user centred systems another issue currently taxing many institutions and organisations is whether it is more efficient and cost effective to invest in open source or commercial repository systems. While the initial financial outlay for commercial systems may appear prohibitive open source systems may have equally significant downstream implementation and maintenance costs. Small organisations and institutions may not have the ability to invest in high-end commercial systems but at the same time they may not be able to sustain the implementation of open source solutions. Moreover, there is confusion between the concepts of "open source" and "open standards" and many implicitly assume that open source systems necessarily implement open standards. In reality, open source systems may be based on proprietary specifications just as commercial systems may be based on open standards. McLean has emphasised the need for frameworks that are hospitable to "best-of-breed" open source and commercial solutions, providing they adhere to open standards (McLean 2004).

Regardless of the type of resource management systems institutions and organisation choose to implement it is crucial that these systems are interoperable and integrated at all levels in order to ensure that resources do not become isolated in content "silos".

Key Questions

- Who owns, manages and controls access to teaching, learning and research resources?
- Who owns, manages and controls access to teaching, learning and research resources once they have been submitted to a repository?
- Who is responsible for controlling which resources deemed to be persistent and where they are managed?
- Can decentralised systems be used to manage digital resources at the organisational or institutional level?
- How can organisations integrate owner centred curatorial repositories and user centred distributed repositories?

4.2 Incentives for using repositories

In order to resolve the "Why" question effectively many of the issues raised above need to be addressed at the strategic policy level. Within the higher education domain and eScience domains there are clear incentives for academic staff to share research resources in the form of peer reviewed scholarly publications but there are few corresponding incentives for any educational practitioners to share teaching and learning resources. Academic measurement and reward systems are also not synchronised with the need for open access information environments (Seaman, 2004). Some authors have argued that reciprocal "learning object economies", which facilitate the sharing of resources within restricted micro economic systems and communities of practice, may encourage teachers to share valuable resources. To some extent the schooling (K-12) sector has had more success in convincing both

management and practitioners of the value of sharing resources. However there are many problematic issues relating to the concept of learning object economies that have already been explored at length in a variety of publications and whitepapers (Campbell, 2003; Johnson 2003).

If organisations and institutions are to encourage their staff to manage their resources more effectively and to share these resources with colleagues and communities of practice there is a significant human resource development overhead to consider. In order to implement an effective information management strategy organisations must ensure that staff have the necessary information management skills to effectively organise their digital assets and meet their institutional obligations.

The challenging issues of digital rights management also needs to be addressed, as practitioners are understandably wary of opening up access to their resources if there are no mechanisms in place to stop these resources from being plagiarised or misused. Organisations need effective digital rights management strategies that can accommodate the requirements of all institutional stakeholders and encompass the full range of digital resources including individual assets, ephemeral teaching and learning resources, learning objects, learning activities, training materials, research outputs, data sets and scholarly publications.

Key Questions

- What are the incentives for educational practitioners to share or publish their resources?
- Where does the responsibility for publishing, sharing and managing resources lie? With teachers and authors? With learning technologists? With librarians? With a combination of the above?
- Who will be responsible for metadata creation and quality assurance? Teachers, learning technologists, librarians or all of the above?
- How can organisations and institutions implement effective digital rights management strategies?

4.3 Workflow

To address many of the questions raised above at the strategic policy level it is necessary to consider information resource management workflow across the organisation. It is essential to distinguish the various institutional stakeholders associated with resources at each stage of their lifecycle from origin to archive and to identify these stakeholders' requirements. A coherent workflow strategy encompassing information management, dissemination, stewardship and archiving needs to be articulated and integrated with the lifecycles of the full range of institutional information resources. All organisations require a consistent digital information management strategy but it is frequently unclear where the responsibility for developing and implementing such a strategy lies. The role of stakeholders in facilitating information management workflow needs to be made explicit and these roles must be integrated at the strategic level.

Key Questions

- What are the opportunities and challenges in implementing formal workflow management processes in the context of digital resource lifecycle management?

5 Services and architectures

In order to meet all stakeholders' requirements institutions and organisations will require a wide range of repository services delivered through a variety of interfaces to manage the full range of information resources at different stages of their lifecycle. These repository services and interfaces need to be identified and articulated at the organisational level to enable the integration of systems to present a seamless information management environment.

In 2003 the Andrew W. Mellon Foundation provided support to the Digital Library Federation to convene an *ad hoc* group of digital librarians, course management system developers and publishers to explore "and discuss some useful next steps to increase the integration of existing digital resources into the working environments of instructors in higher education" (DLF, 2004). The resulting report included a very useful checklist of services and features a repository should provide to make it easier to gather materials for teaching and learning.

For those planning, implementing and evaluating repositories, discussions are often clouded by the failure to distinguish between different components of a repository and the role each has to play. Figure 1 illustrates common repository components.

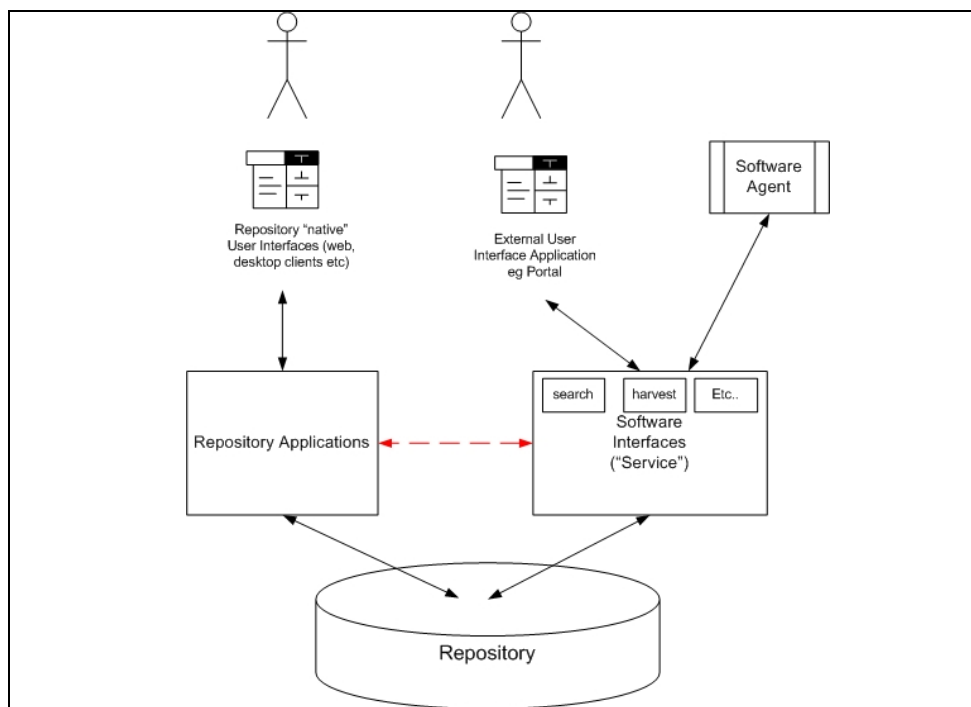


Figure 1 - Repository Components

In Figure 1 the repository encompasses both its internal workings and the store of digital resources. Associated with the store are the “native” repository applications. These applications provide the features and user interfaces for the repository as a branded entity. The software interfaces are the way the repository is exposed to external software. This software might be a user interface application, such as a portal, or a software agent, such as a harvesting agent or search agent. Increasingly these interfaces are being exposed using new service technologies such as Web Services. Repositories will interoperate through these software agents and the exposed software interfaces.

The term “services” can also be confusing. To technical developers and system architects services represent a particular method of providing interfaces to external software agents, however educational practitioners tend to have a more functional view of services; services are the functions that a repository delivers to its users.

As service architectures become more widely adopted, some of the native repository applications such as the user interface application will access the repository through service interfaces.

In line with a general trend of developing infrastructure models, there are a number of initiatives looking seriously at repository architectures, e.g., the JISC JORUM+ project, the ADL CORDRA project, and the Australian ARROW project, an implementation of FEDORA with enhanced services. (URL's for these and other projects are given in the Resources section at the end of this paper).

The JISC Frameworks for E-Learning (ELF) initiative is developing a high level factored view of services. Figure 2 (next page) shows how a subset of these services might be provided over a repository. However not all repositories will, or even should expose all these services.

For each of the services defined a set of specifications, standards, and implementation agreements is required to ensure interoperability between repositories, applications and agents that consume the services.

Key Questions

- What are the core services that a repository should provide?
- How can service definitions be developed that will meet both inter-domain and intra-domain requirements?

(Figure 2 over page)

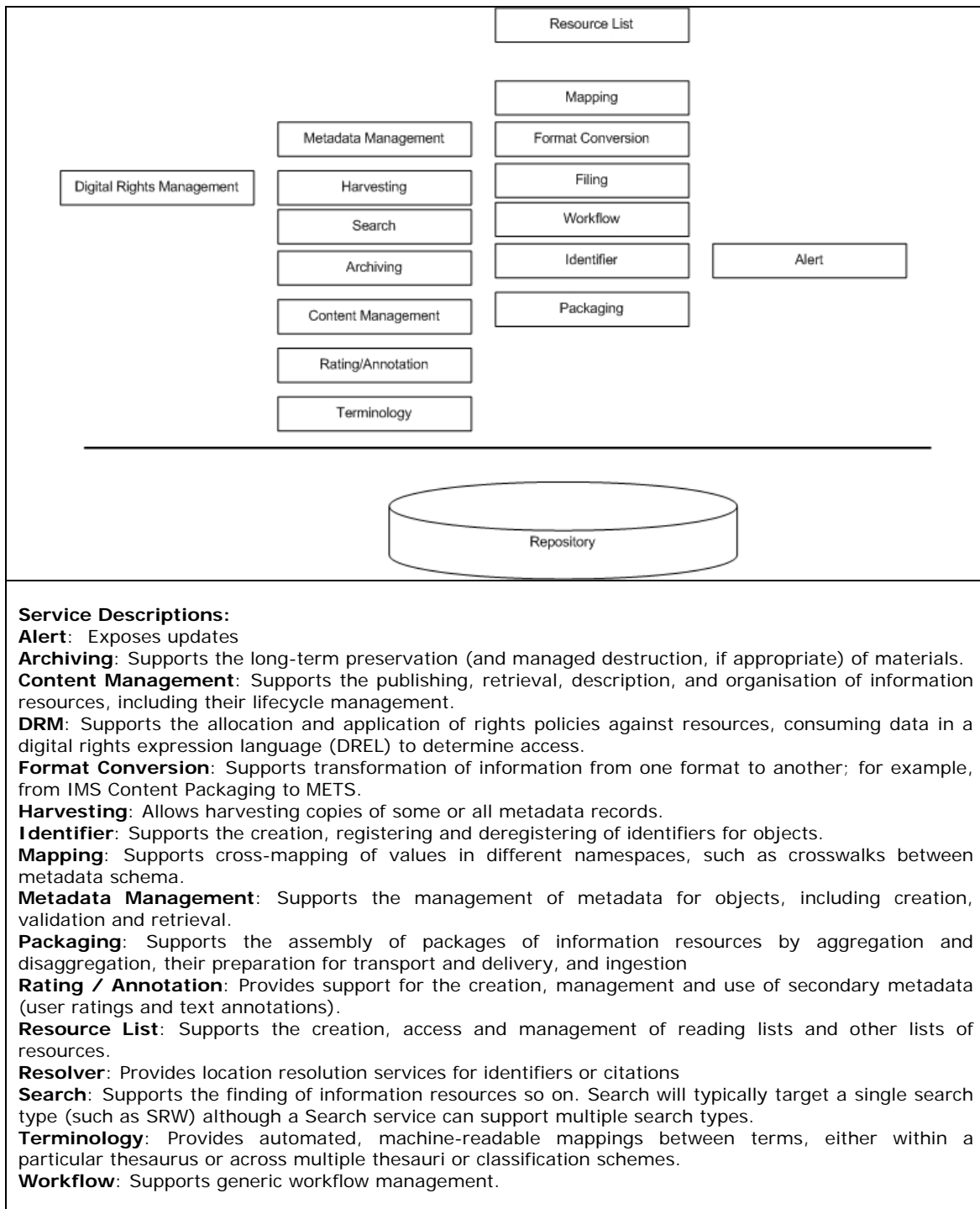


Figure 2 - ELF Subset - Repository Services

6 Resources

Academic ADL Co-Lab Initiatives: Repositories

<http://www.academiccolab.org/initiatives/repositories.html>

Academic ADL Co-Lab directory of repository projects

<http://projects.aadlcolab.org/repository-directory/>

Academic ADL Co-Lab Repository Wiki

<http://tinyurl.com/ytoc>

ADL Content Object Repository Discovery and Registration/Resolution Architecture project (CORDRA)

<http://www.lsal.cmu.edu/lsal/expertise/projects/cordra/index.html>

Arms, William Y., (2000). Digital Libraries, MIT Press

Backing Australia's Future – Information Infrastructure projects (2004)

- The Australian Research Repositories Online to the World (ARROW)
<http://arrow.edu.au>
- Towards an Australian Partnership for Sustainable Repositories
<http://sts.anu.edu.au/apsr/>

Campbell, L. M., (2003). "Engaging with the Learning Object Economy", in A. Littlejohn, (ed) Reusing Online Resources: A Sustainable Approach to eLearning, Kogan Page, London.

CEN/ISSS WS-LT Interoperability of Learning Objects Repositories project

<http://www2.ni.din.de/sixcms/detail.php?id=13884>

D-Lib Magazine

<http://www.dlib.org>

DIDET: Digital Libraries for Global Distributed Innovative Design, Education and Teamwork (A JISC NSF Digital Libraries and the Classroom project)

<http://dmem1.ds.strath.ac.uk/didet/>

Digital Library Federation, (2004). Digital Library Content and Course Management Systems: Issue of Interoperation: Report of a Study Group. DLF. Washington

Digital Repository Certification Task Force

http://www.rlg.org/en/page.php?Page_ID=367

DSpace

<http://www.dspace.org/>

ERPANET / CODATA Workshop, (2004). FINAL REPORT: The Selection, Appraisal and Retention of Digital Scientific Data ERPANET / CODATA Workshop Biblioteca Nacional, Lisbon December 15-17, 2003

<http://www.erpanet.org/www/products/lisbon/LisbonReportFinal.pdf>

FEDORA - Flexible Extensible Digital Object and Repository Architecture
<http://www.fedora.info/>

Gandel, P.B., Katz, R.N., and Metros, S.E., (2004). The "Weariness of the Flesh": Reflections on the Life of the Mind in an Era of Abundance. *EDUCAUSE Review*, 39(2) 40–51.

<http://www.educause.edu/ir/library/pdf/erm0423.pdf>

Holden, Colin, (2003a). Learning Repositories Summit: Initial Research Summary, The Academic ADL Co-Lab with support from The William and Flora Hewlett Foundation

<http://www.academiccolab.org/resources/RepositoryPaper.pdf>

Holden, Colin, (2003b). From Local Challenges to a Global Community: Learning Repositories and the Global Learning Repositories Summit, Academic ADL Co-Lab

<http://www.academiccolab.org/resources/FinalSummitReport.pdf>

IMS Global Learning Consortium, (2003). IMS Digital Repositories v 1.0 Final Specification

<http://www.imsglobal.org/digitalrepositories/index.cfm>

IMS Global Learning Consortium, (2004). Resource List Interoperability v 1.0 Final Specification

<http://www.imsglobal.org/rli/index.cfm>

International Internet Preservation Consortium (IIPC)

<http://netpreserve.org>

[ISO14721:2003](#) Open archival information system -- Reference model

The text at [NASA](#) is possibly different from the official standard but may prove helpful

<http://ssdoo.gsfc.nasa.gov/nost/wwwclassic/documents/pdf/CCSDS-650.0-B-1.pdf>

Johnson, L.F., 2003, Elusive Vision: Challenges Impeding the Learning Object Economy. A macromedia whitepaper

Jorum +, 2004, The JISC Learning Materials Repository Service: JORUM Scoping and Technical Appraisal Study

<http://www.jorum.ac.uk/>

JoDI (Journal of Digital Information), ISSN: 1368-7506

<http://jodi.ecs.soton.ac.uk>

JISC NSF Digital Libraries in the Classroom Programme

http://www.jisc.ac.uk/index.cfm?name=programme_dlitc

Littlejohn, A., (ed), (2003). Reusing Online Resources: A Sustainable Approach to eLearning, Kogan Page, London.

Lionshare project (Penn State University, MIT OKI, Simon Fraser University, Internet P2P Working Group)

<http://lionshare.its.psu.edu/>

Long, Phillip D., (2004). "Learning Object Repositories, Digital Repositories, and the Reusable Life of Course Content" Syllabus issue 5/1/2004
<http://www.syllabus.com/article.asp?id=9258>

Lynch, C., (2003). "Institutional Repositories: Essential Infrastructure for Scholarship in the Digital Age." ARL Bimonthly Report 226, February 2003,
<http://www.arl.org/newsltr/226/ir.html>

McLean, N. and Lynch, C., (2004). "Interoperability between Library information Services and Learning environments – Bridging the Gaps: A Joint White Paper on behalf of the IMS Global learning Consortium & the Coalition for Networked Information."
http://www.imsglobal.org/digitalrepositories/CNlandIMS_2004.pdf

National Library of Australia, Managing Web Resources for Persistent Access
<http://www.nla.gov.au/guidelines/persistence.html>

NISO, (2004). A framework for developing good digital collections
<http://www.niso.org/framework/forumframework.html>

OCLC E-Learning Task Force, (2003). Libraries and the Enhancement of E-learning,
<http://www.oclc.org/index/elearning/default.htm>

RLG/OCLC, (2002). Trusted Digital Repositories: Attributes and Responsibilities An RLG-OCLC Report, RLG Mountain View, CA
<http://www.rlg.org/longterm/repositories.pdf>

Seaman, D., (2004). Institutional Repositories, presentation to JISC Joint Programmes Meeting
<http://www.ukoln.ac.uk/events/jisc-jpm/programme.html>

The Scout Portal Toolkit Project
<http://scout.wisc.edu/Projects/SPT/>

Sun Centre of Excellence for Trusted Digital Repositories
<http://www.coe.hu-berlin.de/>

See also the Technical Infrastructure Trends White Paper for additional resources on repositories.

Meetings (watch for publications): Examples with a focus on repositories.

ALT SURF Spring Conference "Living & learning: ePortfolios and digital repositories"
<http://www.alt.ac.uk/conferences.php>

CNI Spring 2004 Taskforce Meeting
<http://www.cni.org/tfms/2004a.spring/index.html>

European Conference on Digital Libraries (Annual)
<http://www.ecdl2004.org/>

Hong Kong University of Science and Technology Library "International Conference on Developing Digital Institutional Repositories: Experiences and Challenges"
<http://library.ust.hk/conference2004/>

JISC CNI Meeting 2004 "The future of scholarship in the digital age"
<http://www.ukoln.ac.uk/events/jisc-cni-2004/intro.html>

PALS Conference "Institutional Repositories and Their Impact on Publishing"
<http://www.palsgroup.org.uk/palsconference>