Towards a Holistic Approach to Policy Interoperability in Digital Libraries and Digital Repositories

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Abstract

Underpinning every digital library and digital repository there is a policy framework, which makes the digital library viable - without a policy framework a digital library is little more than a container for content. Policy governs how a digital library is instantiated and run. It is therefore a meta-domain which is situated both outside the digital library and any technologies used to deliver it, and within the digital library itself. Policy is also a key aspect of digital library and digital repository interoperability in a common and integrated information space. Policy interoperability - that is the exchange and reuse of policies - is a step beyond policy standardisation. Furthermore, effective and efficient policy frameworks are also one of the Digital Curation Center (DCC), DigitalPreservationEurope (DPE), nestor and Center for Research Libraries (CRL) core criteria for digital repositories. In this article, we share our research on policy interoperability levels and the experimental survey on policy interoperability conducted with real-life digital libraries, as a contribution towards the definition of a Policy Interoperability Framework.[1]

Background and Objective

Digital libraries are complex multidimensional applications (Gonçalves et al., 2004) whose faceted nature has resulted in a variety of diverse disciplinary definitions (Borgman, 2000; Fox et al., 1995; Fox & Marchionini, 1998; Ioannidis, 2001; Ioannidis, 2005; Candela et al., 2006; Candela et al., 2008; Lagoze, 2010). Together with digital repositories and data centres, digital libraries represent the confluence of vision, mandate, content and services constructed around the opportunity of using digital assets. Ross (2003) pinpointed those multidimensional aspects by characterising a digital library as: "the infrastructure, policies and procedures, and organisational, political and economic mechanisms necessary to enable access to and preservation of digital content".

Digital library assets are fragile and require substantial, continuous investment of funding and effort to remain accessible over the longer term. Despite some innovative technological research in the area of digital preservation, the challenges of system development and the increasing intricacy and interrelatedness of digital entities within and among digital libraries have yet to be undertaken in their full complexity. In order for digital curation to be continuous, scalable, interoperable, dynamic and automated, one of the key points would be to substantially improve the ways we describe, represent and manage the objects themselves and their context (Ross, 2007).

The EU funded project DL.org (Digital Library Interoperability, Best Practices and Modelling Foundations)[2] is investigating interoperability challenges in the context of digital libraries, as part of larger ecosystems. DL.org is looking at the DELOS Digital Library Reference Model (DLRM) (Candela et al., 2010) as its conceptual framework. This model, fundamentally engineering-based, is intended as a roadmap to enable the wider digital library community to follow the same route and share a common understanding when dealing with the entities of the digital library universe.

Within this project, the Policy Working Group (2010) investigated the almost unexplored territory of digital library policy at an organisational and semantic level, rather than only a technical level (Innocenti et al., 2010; IDABC, 2004). The term "policy" within Library and Information and Computer Sciences does not always carry a clear meaning and it is often overloaded. We follow the general definition of the Oxford English Dictionary which refers to policy as "a course or principle of action adopted or proposed by an organisation or individual"[3] and the more specifically technical definition of Bonatti and Olmedilla (2009), who refer to policy as "a statement that defines the behaviour of a system that acts on behalf of real users". In real-world digital libraries, policies are usually packages of rules and guidelines, with background information, implementations details and consequences, that are used to conduct businesses in a orderly manner these definitions encompass different types of policies, e.g., management and funding policies, copyright policies (on content and on metadata), privacy policies, security policies, business rules and quality of service specifications, and collection development policies.

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[2] DL.org Project. Retrieved January 12, 2011, from www.dlorg.eu.
[3] Oxford English Dictionary Online. Retrieved January 12, 2011, from http://www.oed.com/.

In the present paper, we discuss policy interoperability levels and the experimental survey on policy interoperability conducted with real-life digital libraries as a step towards the definition of a Policy Interoperability Framework for guiding and supporting digital libraries at organisational, semantic and technical levels.

A Definition of and Rationale for Policy Interoperability

Within the DL.org Policy Working Group, we defined Policy Interoperability as Business Level Interoperability, which allows the comparison of the values and goals of organisations in order to "conduct business" with them. This kind of interoperability takes places at a high (organisational) level, and it is then instantiated at a process level - whether those processes are being handled by human or machine. In terms of standards, policy interoperability is a step beyond policy standardisation and is crucial to achieve useful interoperability between real-world digital libraries.

We can note that underpinning every digital library there is a policy framework. It is the policy framework that makes digital libraries viable - without it a digital library is little more than a container for content. Just as the mechanisms for structuring the content within a traditional library building as a container (e.g., deciding what will be on which shelves) were based upon policy. Policy governs how a digital library is instantiated and run. The policy domain is therefore a meta-domain which is situated both outside the digital library and any technologies used to deliver it, and within the digital library itself. That is, policy exists as an intellectual construct that is deployed to frame the construction of the digital library and its external relationships, and then more operational policies are represented in the functional elements of the digital library. So, policy permeates the digital library, from conceptualisation through to operation, and needs to be represented in abstractions of digital libraries at these various levels. Furthermore, effective and efficient policy frameworks are also one of the DCC, DPE, nestor and CRL core criteria for digital preservation repositories (CRL et al., 2007).

Policy Interoperability Levels

Interoperability is among the most critical challenges to be addressed when designing and developing systems as independent "collections" that could or should co-operate and rely on each other to accomplish larger tasks. There is not yet a full interoperability solution or approach that is sufficient to serve the overall needs of digital library organisations and digital library systems. In fact, there does not seem to be yet a single definition of interoperability that is unanimously accepted either by the research or professional communities, although the IEEE (1991) and ISO/IEC 2382-2001 (2001) definitions can be considered as a guiding reference.

In order to address the interoperability challenge exhaustively, the DL.org project is adopting a multi-level approach, considering organisational, semantic and technical interoperability following the classification of the European Interoperability Framework for eGovernment services (IDABC, 2004).

At an organisational level, interoperability is a property referring to the ability of diverse systems and organisations to work together. Today, organisational interoperability is considered a key step to move from isolated digital archives and digital libraries towards a common information space, allowing users to browse

through different resources within a single integrated environment (Fox et al., 1995; Borgman, 2000; Miller, 2000; Ross, 2008; Lagoze, 2010).

Some studies have addressed organisational interoperability in fields as diverse as engineering, military defence, Geographic Information System (GIS), data grids, open source software, public administration, current research information systems, e-learning (e.g., IDABC, 2004; Bishr, 1998; Clark & Jones, 1999; Tolk, 2003; Tolk & Muguira, 2003; Gridwise Architecture Council, 2005; Assche, 2006; Tolk et al., 2007; Ford et al., 2007; euroCRIS, 2008) as well as the digital library domain (Dekkers, 2007; Bygstad et al., 2008; Peiffer et al., 2010), while others have addressed digital preservation from an holistic point of view (Jones, 2009; Dappert, 2009; Hitchcock et al., 2007; Beagrie et al., 2008; Innocenti et al., 2009). But organisational interoperability, in the context of digital preservation, is still a challenging and almost uncharted research area for digital libraries.

Achieving effective organisational interoperability between digital libraries requires radical changes at several levels, because it can imply a radical change in the way that organisations work, manage and share their digital assets. It has been noted that these changes can be achieved through a ongoing process in which the organisation's systems, procedures and culture are managed towards maximizing the opportunities for exchange and re-use of information, whether internally or externally (Miller, 2000).

Policies can greatly affect interoperability, and can be interoperable or not. But interoperable policies – especially at machine-machine level – are not common. In order to interoperate, the policies of two or more digital libraries should speak about the same things in comparable ways, allowing the reconciliation of permissions and prohibitions. They should also be structured in such a way as to be able to identity appropriate external as well as internal policies.

Experimental Survey on Policy Interoperability in Real -Life Digital Libraries

The DL.org Policy Working Group surveyed policy interoperability examples from a selected representative sample of cross-domain international medium to large scale public and commercial digital libraries, digital repositories, digital archives and federated digital library services. This survey aimed to gain insight into areas that underpin aspects of interoperability (such as those around metadata and network protocols). This study was meant to contribute helping library managers, digital librarians, information specialists, researchers, digital library developers and strategists to better understand how policies are represented, codified, implemented and shared in digital libraries, digital repositories and data centres.

The definition of a Digital Library provided by Seamus Ross (2003) was borne in mind when targeting potential participants for the DL.org Policy Interoperability Survey. To represent the broad spectrum of digital libraries, we selected digital libraries, digital repositories and federated services based upon the following criteria: international character and reach; academic, institutional and commercial digital libraries, offering free access and/or access upon authorisation; inclusion of full-text documents; good coverage of a variety disciplines. Particularly challenging was the

task of identifying the appropriate contact people within each library. We received twenty six replies from over thirty libraries contacted, and of these, fifteen completed the survey. The survey respondents included: ACM Digital Library[4], Calisphere[5], DANS[6], DRIVER[7], E-LIS[8], Europeana portal[9], ITHAKA[10]: JSTOR[11] and PORTICO[12], NARA[13], Nemertes institutional repository of the University of Patras[14], NSDL[15], Padua@Research institutional repository of University of Padua[16], UK Data Archive[17], University of Chicago Digital Repository[18], and US Geological Survey Digital Library[19].

There has been some work looking at policies in this domain (such as in Jones, 2009; Dappert, 2009; Hitchcock et al., 2007; Beagrie et al., 2008; PLEDGE Project[20]; Smith & Moore, 2007). However, there has been little, if any, work on how these policies support interoperability between digital collections and how the policies themselves can interoperate, be reused and assessed, possibly in a machine-encoded way.

The survey investigated:

- Any policies, strategies, frameworks, programs, plans or statements that have been prepared to guide how they develop and exploit aspects of their digital library/digital repository's information management;
- How these policies, strategies, frameworks, programs, plans or statements affect or are affected by interoperability.

The survey was organised into three distinct sections. The first section was related to scoping the digital library and organisation staff involved in the digital library policies. In the second section, the survey respondents were invited to reply to questions focused on policies for access, preservation, metadata, networks, collection development, intellectual property, authentication and service level agreements. The third section was dedicated to collecting information specifically on how policies are represented, codified, implemented and shared in the digital library (DL.org Policy Working Group, 2010).

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[4] Association for Computing Machinery (ACM) Digital Library. Retrieved January 28, 2011, http://portal.acm.org/.

[5] Association for Computing Machinery (ACM) Digital Library. Retrieved January 28, 2011, http://www.cdlib.org/services/dsc/calisphere/.

[6] Data Archiving and Networked Services (DANS). Retrieved January 28, 2011, http://www.dans.knaw.nl/.

[7] Digital Repository Infrastructure Vision for European Research (DRIVER). Retrieved January 28, 2011, from http://www.driver-repository.eu/.

[8] Eprints in Library and Information Science (E-LIS). Retrieved January 28, 2011, from http://eprints.rclis.org/.

[9] Europeana portal. Retrieved January 28, 2011, from http://www.europeana.eu/portal/.

[10] National Archives and Records Administration (NARA). Retrieved January 28, 2011, from http://www.archives.gov/.

[11] JSTOR. Retrieved January 28, 2011, from http://www.jstor.org/.

[12] PORTICO. Retrieved January 28, 2011, from http://www.portico.org/digital-preservation/.

[13] ITHAKA. Retrieved January 28, 2011, from http://www.ithaka.org/.

[14] Nemertes. Retrieved January 28, 2011, from http://nemertes.lis.upatras.gr/dspace/.

[15] National Science Digital Library (NSDL). Retrieved January 28, 2011, from http://nsdl.org/.

[16] Padua@Research institutional repository of University of Padua http://paduaresearch.cab.unipd.it/.

[17] UK Data Archive. Retrieved January 28, 2011, from http://www.data-archive.ac.uk/.

[18] University of Chicago Digital Repository. Retrieved January 28, 2011, from http://www.lib.uchicago.edu/e/dl/program.php3.

[19] US Geological Survey (USGS) Digital Library. Retrieved January 28, 2011, from http://www.usgs.gov/.

[20] PLEDGE Project. Retrieved January 12, 2011, from http://pledge.mit.edu.

We gained a better understanding of how policies can help or hinder interoperability, and which steps could be taken to develop a general framework for interoperability between digital collections that could support the wider community in adapting, generating and assessing interoperable policies.

Preliminary Results and Implications

For analysis purposes, the survey replies have been regrouped into seven classes of approaches and tools for managing policies and policy interoperability: access, preservation, network, intellectual property, authentication, evaluation and assessment, representation and enforcement. At the time of this paper, we are in the process of following up with the survey respondents to further investigate some of the research themes that emerged.

Almost all respondents indicated that their digital library/repository/archive had a written strategy or plan, either as part of a library strategic plan or as independent entity within the organisation. The areas covered by written, formalised policies were indicated as shown in Figure 1, with a prevalence of written policies for Intellectual Property, Collection Development, Metadata and Access, and fewer formalised policies for Preservation and Networks.
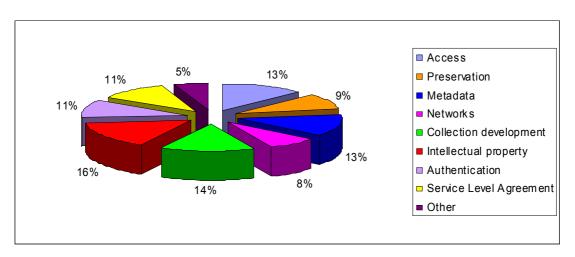

Figure 1. DL.org Policy Interoperability Survey: Existence of written policies per areas of interest. © DL.org Policy Working Group.

However, in terms of policy exchange and reuse with other entities, apparently only in the areas of Preservation, Access, Collection Development and Metadata have the existing policies of the respondent organisations been amended and matched with the policies of other organisations (Figure 2). For example, some of the indicated approaches and tools used to handle policy interoperability for access included EML[21], DOI, the COUNTER 3 Code of Practice, the DLF ERM[22] Initiative, and XACML[23]. For example, respondents indicated that some following approaches and tools, if consistently used to handle access policies, represented a common basis necessary to achieve policy, as well as functional, interoperability: online technical registry

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[21] Election Markup Language
[22] Digital Library Federation Electronic Resource Management
[23] eXtensible Access Control Markup Language

PRONOM; DROID[24]; JHOVE[25]; UDFR[26]; GDFR[27]; Planets Testbed Beta; OAIS[28]; TRAC[29]; DRAMBORA[30] Interactive toolkit; LOCKSS[31]; Portico's Digital Preservation Service, EAD[32]; METS[33]; OAI-PMH[34]; XML; PREMIS[35]; DIDL[36]; DCMI[37]; MARC[38]; and the ONIX[39] protocol whose consistent use is felt to represent a common basis necessary to achieve policy, as well as functional, interoperability. One of the reasons for such diverse replies might be that the operational definition of "policy" includes a broad variety of documents, configuration files and software, which are often tightly tied to processes and procedures that are often not explicitly formalised within the institution. Or perhaps the wording of those policies might be too vague within the organisation, and therefore susceptible to diverse interpretations and implementations.
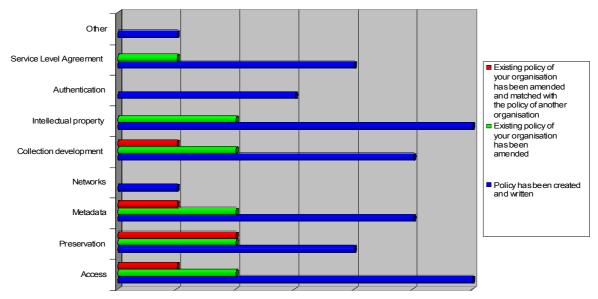

Figure 2. DL.org Policy Interoperability Survey: How policies reflect interoperability needs per areas of interest. © DL.org Policy Working Group.

All respondents indicated an interest or need to interoperate with peer and smaller/bigger organisations, both in the public and private sector. But interestingly few written policies were indicated as available to regulate this interaction, in particular with smaller/bigger organisations. Perhaps the people affected by those policies are not aware of them, or maybe interactions are managed primarily through other regulatory documents rather than policies.

[24] DROID: Digital Record Object Identification.
[25] JHOVE: JSTOR/Harvard Object Validation Environment.
[26] UDFR: Unified Digital Format Registry.
[27] GDFR: Global Digital Format Registry.
[28] OAIS: Open Archival Information System.
[29] TRAC: Trusted Repositories Audit & Certification.
[30] DRAMBORA: Digital Repository Audit Method Based On Risk Assessment.
[31] LOCKSS: Lots of Copies Keep Stuff Safe.
[32] EAD: Encoded Archival Description.
[33] METS: Metadata Encoding and Transmission Standard.
[34] OAI-PMH: Open Archives Initiative - Protocol for Metadata Harvesting.
[35] PREMIS: Preservation Metadata Maintenance Activity.
[36] DIDL: Digital Item Declaration Language.
[37] DCMI: Dublin Core® Metadata Initiative.
[38] MARC: MAchine-Readable Cataloging.
[39] ONIX: ONline Information eXchange.

One further finding that stood out from the survey was related to policy encoding. Current digital libraries are moving towards it, but there are almost no real-life examples yet. There is a clear lack of policy formalisation and representation methods within organisational and semantic interoperability levels, though limited formal specifications are supported, e.g. for network management, security and privacy (Bishop, 2004; W3C Policy Languages Interest Group, 2010a). So far, formally-encoded organisational and semantic policies haven't been implemented in actual digital libraries - even the ones that interoperate with an Integrated Rule-Oriented Data System (iRODS) - and there is, as yet, no standard policy language for the Web, although there are ongoing efforts to map research languages like the AMORD In RDF (AIR) Policy Language (Kagal, 2007) to the new W3C recommendation standards for the Rule Interchange Format (RIF) (W3C, 2010b). Policies, in general, only describe the 'what' and not the 'how', so the codification and representation of policies is particularly important in transforming policies into processes that can be enforced, are traceable and reproducible and that can, therefore, be ultimately reused and exchanged within the digital library or with external digital libraries and repositories. True interoperability should be automated and scalable, but there are not yet methods available to encode policies in a way that makes them automatically implementable. One current alternative approach for achieving this could be to use community conventions – e.g., XACML for authorization rules, or Creative Commons licenses for access.

The lack of policy encoding standards to express more than just technical aspects of policies also emerged in the replies to the survey question "How do you measure policy interoperability?" The lack of measurements and compliance assessment is in general one of the reasons why policies are ignored within an organisation, and even when measurements are in place, they might not be collected and analysed consistently enough to ensure compliance. For all areas, and in particular for Service Level Agreement, Authentication and Collection Development, more than half of our survey respondents indicated not having measurements in place. Some respondents mentioned indirect measurements, in particular for Access and Metadata, while others indicated having a measurement policy for Preservation and Metadata interoperability.

An additional implication from this study is that some technical interoperability of policy is possible, but only for very specific and technical cases (e.g., access control via Shibboleth[40]). Furthermore, in real-life digital libraries there are usually no examples of simple point-to-point policy interoperability: the most interesting policy cases of interoperability take place either when there are interactions between equals (e.g., when a digital library agrees to become interoperable with another on some basis) or according to a hierarchical model of interaction (e.g., when DRIVER (DRIVER, 2008) requires all participating repositories to conform to its Guidelines 2.0 for content providers).

In general, based on the survey responses, we suggest that rather than discussing "solutions" for policy interoperability, it would be more appropriate to talk about a "future" state: not necessarily only best practices, but a state of desire that digital library stakeholders will try to put into practice. Some elements are not in place today, but would be envisioned as necessary for the interoperability of polices directing digital libraries. Some desired areas for policy interoperability are, for example, related

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[40] Shibboleth. Retrieved January 28, 2011, from http://shibboleth.internet2.edu/.

to access policies (e.g. authentication and authorisation, Service Level Agreements for presenting content) and licensing policies (as documented in the recent "Public Consultation draft of Europeana Licensing Framework" (Peiffer et al., 2010), which provides models for licensing agreements with data providers). In both cases, making policies machine-readable would make them easier to manage. We suggest that research should focus on human-machine interaction, e.g. how licensing policy interoperability might be achieved automatically in the near future.

We also suggest that such a holistic approach to policy interoperability should not be described as an absolute in engineering terms, because of the need to capture the richness of organisational, semantic and technical aspects within human-computer interactions. The description of policy interoperability implies levels that could be better described e.g. using real-world scenarios.

Further Work

Upon the promising findings of our survey, our next steps comprise of:

1. **Including our findings in the new DL.org enhanced version of the DELOS Digital Library Reference Model and in the DL.org Digital Library Cookbook.** The survey results outlined further directions for research in these areas and are being included in the DL.org project outputs. By presenting our activities and research outcomes on policy, we hope to contribute to the work of other digital library interoperability efforts and eventually offer the community a more comprehensive approach towards policy interoperability;
2. **Creating a DL.org Digital Library Reference Model Checklist.** This checklist, currently being developed by the DL.org project team under the lead of the Policy and Quality Working Group, will incorporate a set of questions related to each domain that will enable those with existing digital libraries (or in the process of designing them) to determine whether or not their library is compliant with the *DELOS Digital Library Reference Model*;
3. **Investigating formalisation models for expressing both organisational and semantic interoperability within digital libraries.** The PLEDGE project at Massachusetts Institute of Technology and our survey provide evidence that very few current digital libraries have formal policies in place. However, making digital library policies machine-readable would make it easier to manage and exchange them in an interoperable environment: identifying the level of precision or granularity at which policies are defined, from the very high level and abstract to the very concrete and detailed, would support the mapping of policies between organisations. In order to address this issue for expressing policy in a machine-encoded way at the organisational and semantic level, we are looking at the PLEDGE policy categorization, which focuses on the determination of a set of policies that affect operational digital preservation archives, with the goal of developing standardised means of recording and enforcing them using rules engines (Smith & Moore, 2007).

Conclusions

To our knowledge, this is the first work investigating policy interoperability for digital libraries using a three-tier interoperability level. The first results presented here already indicate a high relevance for approaching policy interoperability not only from a technical perspective but also, and foremost, from an organisational and semantic point of view. We envisage continuing this work with real life cases and actual data, leading to the creation of a convenient approach that digital library practitioners and managers can use to address policy interoperability.

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