

PROJECT FINAL REPORT

Grant Agreement number: 231551

Project acronym: DL.ORG

Project title: DL.org:Coordination Action on Digital Library Interoperability, Best Practices, and Modeling Foundations

Funding Scheme: Coordination Action (CA)

Period covered: from 1 December 2009 to 28 February 2011

Name of the scientific representative of the project's co-ordinator¹, Title and Organisation:

Donatella Castelli, Dr, CNR-ISTI

Tel: +39 050 3152902

Fax: +39 050 3153470

E-mail: Donatella.Castelli@isti.cnr.it

Project website address: www.dlorg.eu

¹ Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

1 Final publishable summary report

1.1 Executive Summary

The goals of the **DL.org Coordination Action on Digital Library Interoperability, Best Practices, and Modeling Foundations** were to:

- Create a networked community of theoreticians and practitioners in the field of Digital Libraries in order to discuss the main problems faced when building large scale interoperable distributed heterogeneous digital library infrastructures.
- Improve and enhance the DELOS Digital Library Reference Model, a conceptual tool enabling the description of the digital library universe.
- Provide a conceptual framework within which to describe the main technical and organizational DL interoperability problems and solutions.
- Produce best practices, technology patterns, and guidelines in order to guide and assist the developers of interoperable digital library systems.
- Widely disseminate the project findings.
- Contribute to the education in the field of digital libraries.

The core DL.org community has been developed by close engagement with international digital library theoreticians and practitioners, specifically through **six Working Groups** corresponding to the six main concepts of the Digital Library Reference Model (Content, User, Functionality, Quality, Policy, Architecture) and a **Liaison Group** comprising internationally recognized experts in the field of digital library. Additionally, strong links have been established with relevant DL projects and organizations as **Strategic Alliances**. Forty such alliances have been forged, twenty-seven of which are funded by the EC, representing six different Directorate General Units alongside two ESFRI projects. The core community has also been built by mobilizing the Library and Information Science community, educationalists, computer scientists, researchers and students at various stages in their academic careers, particularly through **two international workshops, three national events** (Greece, Italy and the UK), the **Autumn School**, alongside regular **sessions** and **presentations** at external events, illustrating the value of face-to-face interaction with target groups.

The DL.org and wider community are now well placed to address Digital Library development and interoperability challenges thanks to the suite of outputs generated:

- The **DL.org Digital Library Reference Model**, enriching and enhancing the DELOS Digital Library Reference Model, where a better definition of the basic concepts has been produced, new important concepts have been introduced, and the interrelationships between the basic concepts have more appropriately been defined.
A number of lightweight introductory publications for specific stakeholders, particularly librarians have been generated from the Reference Model:
 - **Digital Library Reference Model Conformance Checklist** to enable assessors to determine whether or not a digital library conformed to the Digital Library Reference Model.

- **Digital Library Manifesto** (abridged).
- **DL.org Technology and Methodology Digital Library Cookbook** containing best practices and technology patterns for tackling the different interoperability problems, both technical and organizational, arising in the context of heterogeneous cooperating digital library systems. An abridged version of the Cookbook is among the suite of publications.
- An extensive **Survey of the State-of-the-Art** of research and practice in interoperability in digital libraries has been conducted. Surveys with the Open Access Repository community have also yielded important findings, particularly from a Policy and Quality perspective.
- Findings have been presented in a number of **scientific papers** at several international scientific and educational events, including conferences, workshops, sessions, panels, etc. and published for the most part in Conference Proceedings or international journals.
- Target groups and the community members have been kept up to speed on DL.org findings and initiatives through regular **dissemination activities**, such as eNewsletters and announcements, while interviews with leading figures have offered a high-level view of the evolving digital library landscape. DL.org will continue to engage with these communities through post-project activities, such as a conference presentation, workshop and tutorial, and by liaising with initiatives of relevance. The final dissemination campaign will bring into sharp relief all the published outputs aimed at enabling target groups.

Finally, DL.org has made considerable contributions to education in the field of digital libraries. The Autumn School and national event in Italy have generated multimodal resources for re-use by educationalists and students, by engaging closely with renowned lecturers and coordinators of international post-graduate LIS programmes. International cooperation, particularly the alliance with the U.S. Digital Library Curriculum Development project, which is funded by the NSF, has also played a key role in generating modules which are now hosted on the Digital Library section of Wikiversity, ensuring that DL.org contributions are widely available.

2 Summary Description of Project Context and Objectives

2.1 Project Context

The Digital Library universe is complex as it is the meeting point of many scientific disciplines and, thus, draws concepts, models, and approaches from several scientific fields including data management, information retrieval, library sciences, information systems, human-computer interaction, etc. The growth and evolution of this universe in terms of models, approaches, solutions and systems has led to the need for common foundations capable of setting the basis for better understanding, communicating and stimulating further evolution in this area. The DELOS Digital Library Reference Model, developed in the context of the DELOS Network of Excellence on Digital Libraries, aimed at contributing to the creation of such foundations. The DELOS Reference Model exploited the collective understanding on Digital Libraries that was acquired

by international research groups active in the Digital Library field for many years. The resulting document identified the set of concepts and relationships that characterise the essence of the Digital Library universe. This model should be considered as a roadmap allowing the various stakeholders involved in the Digital Library domain to follow the same route and share a common understanding when dealing with the entities of such a universe.

However, as the nature of the Digital Library universe is dynamic, new concepts and relationships have emerged that need to be well defined and appropriately introduced in the Reference Model.

DL.org has addressed exactly this need, that is, to enrich and enhance the Reference Model by introducing the principles governing such a model as well as a set of concepts and relationships that collectively capture the intrinsic nature of the various entities of the Digital Library universe.

In parallel to this foundational effort, there is in action a big effort, both in terms of human resources and funding, supported by the CEU research programs aiming at developing large digital information systems, including thematic digital libraries, institutional digital repositories and discipline-specific digital data libraries.

These digital information systems are optimized for supporting the full life cycle of the digital information (capture, collection, curation, documentation, archiving, and publication).

Significant attempts towards this direction are the Europeana and OpenAIRE efforts.

Connecting these systems and enabling them to exchange data and information and interoperate within a framework of shared policies is an emerging need. Achieving this will contribute to the creation of digital information infrastructures supporting multidisciplinary activities.

The main technical challenge to be tackled regards the fact that when data/information/knowledge is moving between disciplines have to cross a number of “knowledge boundaries” without semantic distortions.

DL.org has addressed the difficult problem of making interoperable these information infrastructures by adopting a holistic approach. In essence, it investigated techniques and approaches that make interoperable the main concepts of the universe of these infrastructures: content, user, functionality, policy, and quality. Technology patterns, best practices, and recommendations have been produced in order to guide the development of interoperable information infrastructures.

With the emerging of the digital libraries there is an increasing need for new professional profiles able to develop, administrate, and operate these infrastructures and to curate their content. There is a need for educating these new professionals.

DL.org has also addressed this need by producing teaching material based on the work carried out regarding the definition of a Reference Model for Digital Libraries and a Digital Library Technology and Methodology Cookbook.

2.2 Project Objectives

- **To create a networked community of theoreticians and practitioners in the field of Digital Libraries in order to discuss the main problems faced when building large scale interoperable distributed heterogeneous digital library infrastructures**

As a Coordination Action, one of the primary objectives of DL.org has been to build a networked community of theoreticians and practitioners in two main ways. Firstly, the establishment of six Working Groups, one for each concept captured by the DELOS reference Model, a Liaison Group and three External Advisors. Secondly, through the organization of two international workshops, three national events in Greece, Italy and the UK, as well as sessions hosted and presentations at external events, where project findings and outputs have been presented.

Such an approach has fostered the development of the future interoperable digital library infrastructures springing from a synergetic action between these two constituencies.

These two activities have led to the establishment of 40 Strategic Alliances over two years in order to foster knowledge exchange, disseminate pioneering work and co-host events and sessions. On a European level, six different Directorate General Units of the European Commission are represented:

- Cultural Heritage and Enhanced Technology Learning, e.g. SHAMAN
- GÉANT and e-Infrastructures, e.g. DC-Net, GRDI2020, OpenAIRE, VENUS-C.
- Education and Culture DG - Erasmus Mundus programme, e.g. DILL
- eContentPlus: e.g. Europeana, EUScreen
- Research and Development, e.g. Scientix
- ICT for Sustainable Growth, e.g. ENVISION.

DL.org has also established synergies with initiatives supported by the European Strategy Forum on Research Infrastructures (ESFRI), e.g. DARIAH - Digital Research Infrastructure for the Arts & Humanities and LIFEWATCH - eScience & technology infrastructure for biodiversity data & observatories. National initiatives recruited include three US-based initiatives: Digital Library Curriculum Development: Virginia Tech and the Library & Information Science Graduate School, University of North Carolina at Chapel Hill, Memento and Streams, Structures, Spaces, Scenarios and Societies (5S).

In addition, DL.org has engaged with an active community made up of 280 members, 52% of which comes from the Library and Information Science community, bringing over 45 position statements and testimonies during events hosted. Members come from 47 countries in Europe and globally.

- Twenty-three European countries: Austria, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Netherlands, Norway, Poland, Serbia, Slovakia, Spain, Sweden, Switzerland, UK.
- Twenty-four countries around the world: Australia, Bangladesh, Belarus, Burundi, Canada, China, Colombia, India, Indonesia, Iran, Japan, Malawi, New Zealand, Nigeria, Pakistan, Philippines, Russian Federation, Saudi Arabia, Singapore, South Africa, Taiwan, Uganda, U.S., Vietnam.

- **To improve and enhance the DELOS Digital Library Reference Model, a conceptual tool enabling the description of the digital library universe**

The DELOS Digital Reference Model is the result of an activity carried out under the DELOS Network of Excellence by a small group of researchers.

Its purpose was to set the foundations and identify the main concepts of the Digital Library universe. It introduced the relationships among three kinds of relevant “systems” in this area: Digital Library, Digital Library System, and Digital Library Management System. It presents the main concepts characterising these systems, i.e., content, user, functionality, quality, policy, and architecture, and it has identified the main professional profiles involved in the design, development, operation, and administration of these systems.

The objective of DL.org has been to produce an enriched and enhanced version of the “DELOS Reference Model”, by better defining the basic concepts of it, introducing new important concepts, and defining more appropriately the interrelationships between its basic concepts. In addition to the **DL.org Digital Library Reference Model**, the definition of the concepts of the Digital Library universe have enabled the creation of a “**Digital Library Reference Model Conformance Checklist**” to enable assessors to determine whether or not a digital library conforms with the Digital Library Reference Model.

The involvement of the international Digital Library community has been instrumental in analysing the different aspects of the Reference Model, collecting feedback and suggestions from members of this community.

- **To create a conceptual framework within which to describe the main technical and organizational DL interoperability problems and solutions**

Interoperability intended as the ability of two entities to work together very much depends on the working context in which these two entities are embedded. In the context of Digital Libraries, it was decided to consider interoperability from six different perspectives corresponding to the six main concepts of the Digital Library universe (content, user, functionality, quality, policy, and architecture). In order to make easier the analysis of the DL interoperability problems and the description of the solutions an Interoperability Framework has been defined. This Framework allows also to make an assessment of the efficiency and effectiveness of the different approaches to interoperability.

In order to define this Framework instrumental has been an extensive survey on the state-of-the-art of the research and practice in the field of interoperability.

This Framework has also been used to analyze the approaches to interoperability adopted by on-going relevant projects.

- **To produce best practices, technology patterns, and guidelines in order to guide and assist the developers of interoperable digital library systems**

The objective was to translate the interoperability techniques and approaches identified during the state-of-the-art survey into technology patterns, best practices and implementation guidelines enabling the digital library system designers and developers to choose the most appropriate solutions to their interoperability problems while building their system.

Several Digital Library interoperability scenarios have been identified and described in terms of problem-solution according to the methodology described in the Interoperability Framework.

The identified technology patterns, best practices, and guidelines have been included into the Deliverable “Digital Library Technology and Methodology Cookbook”.

- **To widely disseminate the project findings**

The dissemination of the Project findings was an important objective of DL.org. In particular, by promoting the DL Reference Model the objective was to contribute to creating among the DL stakeholders a common understanding and language about the DL domain.

By promoting the Cookbook, the objective was to assist Digital Library system designers and developers in identifying the appropriate interoperability scheme for their system.

By promoting the results of the in-depth survey on interoperability, the objective was to present to the research community several interesting open DL interoperability problems and stimulate this community to push forward the state-of-the-art in this difficult topic.

To achieve these objectives instrumental has been the organization of several scientific events including workshops, special networking sessions, and panel. In addition, the dissemination activity of the Project was supported by a rich production of dissemination material including posters, flyers, e-Newsletters, and a dynamic web site.

- **To contribute to the education in the field of digital libraries**

The emerging of Digital Libraries demands for new professional profiles. New professional skills must be created in order to enable the new professionals to effectively and efficiently interact at different levels and with different tasks with the Digital Library systems. Digital Library curators, Librarians, system administrators, system designers, and application developers are the new skills that must be created. There is, therefore, a need for educational material. One important objective of DL.org was the production of education material for these new skills.

In order to be able to produce such material, instrumental have been the two Deliverables: the “DL Reference Model” and the “Technology and Methodology Cookbook”. In fact, teaching materials have been produced by extracting content from these two Deliverables. These materials

contributed to the creation of the Module “Conceptual frameworks, models, theories, definitions” of Wikiversity.

Finally, the organization of an Autumn School and a Workshop in cooperation with International Master in Digital Library Learning (DILL- under the European Union’s Erasmus Mundus Program) helped to acquiring a better understanding of the education needs and to customize more appropriately the teaching materials.

2.3 Description of the main S&T results/foregrounds

Enriched and Enhanced Version of the DELOS Digital Library Reference Model

The project has produced an enhanced and enriched version of the DELOS Digital Library Reference Model. This version maintains, consolidates and enhances the DELOS RM by applying a number of revisions and extensions. It introduces the principles governing the Reference Model as well as the set of concepts and relationships that collectively capture the intrinsic nature of the various entities of the Digital Library universe. Because of the breadth of the Digital Library universe and its evolving nature, as well as the lack of any previous agreement on its foundations, the Reference Model is by necessity dynamic. The model is extensible and, should other concepts be needed, they could easily be added in the appropriate place. Continuous evolution of this document will lead to well-formed and robust definitions, shared by the Digital Library community.

The document describing the Reference Model is organised in four parts, each potentially constituting a document on its own. Each of the four parts describes the Digital Library universe from a different perspective between abstraction and concretisation. Thus each part is equally important in capturing the nature of this complex universe. The second part is based on the first one, and the third part is based on the second, i.e., they rely on the notions described previously when introducing additional information that characterises these notions more precisely. In particular, “PART I: The Digital Library Manifesto” sets the scene governing the whole activity and introduces the main notions characterising the whole Digital Library universe in quite abstract terms; “PART II: The Digital Library Reference Model in a Nutshell’ treats these notions in more detail by introducing the main concepts and relationships related to each of the aspects captured by the previous one; “PART III: The Digital Library reference Model Concepts and Relations” describes each of the identified concepts and relations in detail by explaining their rationale as well as presenting examples of their instantiation in concrete scenarios; finally, “PART IV: Digital Library Reference Model Conformance Checklist” identifies and documents a set of criteria that can be used to determine whether or not a ‘digital library’ is compliant with the Digital Library Reference Model (see section 4.1.3.2).

Although it is possible to choose different routes through the document, or simply focus on a single part, the entire document is structured so that it can also be read from cover to cover.

Section I.1 introduces “PART I: The Digital Library Manifesto” by providing the driving force behind the whole activity. Section I.2 presents the relationships between the three types of relevant ‘systems’ in the Digital Library universe, namely Digital Library (DL), Digital Library System (DLS) and Digital Library Management System (DLMS). Section I.3 describes the main concepts characterising the above three systems and thus the whole Digital Library universe, i.e., organisation, content, user, functionality, quality, policy and architecture. Section I.4 introduces the main roles that actors may play within digital libraries, i.e., end-user, manager and software developer. Section I.5 describes the reference frameworks needed to clarify the DL universe at different levels of abstraction, i.e., the Digital Library Reference Model and the Digital Library Reference Architecture. Section I.6 records some concluding remarks on The Digital Library Manifesto.

Section II.1 introduces “PART II: The Digital Library Reference Model in a Nutshell” by summarising the content of the Manifesto and setting the basis for reading and using the rest of this part. Section II.2 presents the constituent domains by briefly describing their rationale and providing for each of them the concept map that characterise them by introducing the main related concepts and the relations connecting them. Section II.3 introduces the reader to possible exploitations of the model. In particular, it addresses Interoperability and Preservation issues. For each one, it describes the issue by pointing out the tools that the Reference Model makes available for dealing with it. Section II.4 discusses related work. In particular, it highlights the similarities and differences between this Reference Model and similar initiatives like the 5S Framework and the CIDOC Conceptual Reference Model. Section II.5 records some concluding remarks on the Digital Library Reference Model as presented in PART II.

Section III.1 introduces “PART III: The Digital Library reference Model Concepts and Relations” by highlighting the role of this part. Section III.2 presents the hierarchy of Concepts constituting the Reference Model. Section III.3 provides a definition for each of the 200+ Concepts currently constituting the model. Each definition is complemented by the list of relations connecting the concept to the other concepts, the rationale for including this concept in the model, and examples of concrete instances of the concept in real-life scenarios. Section III.4 presents the hierarchy of the identified Relations. Section III.5 provides a definition for each of the 50+ Relations currently constituting the model. Each definition is complemented by the rationale for including it in the model and some examples of concrete instances in real-life scenarios.

Section IV.1 introduces “PART IV: Digital Library Model Conformance Checklist” (see section 4.1.3.2)

Digital Library Reference Model Conformance Checklist

In a wide range of domains from aviation to construction and from healthcare to project management checklists are increasingly common as mechanism to control process quality (e.g. by reducing errors), to ensure compliance with performance guidelines, to provide transparent mechanisms for understanding and using complex systems, and to facilitate consistency of action between practitioners. They enable audit consistency, and in providing a method for understanding complex systems. The DL.org project has elaborated a “*Digital Library Reference Model Conformance Checklist*”. This checklist provides a set of statements that will

enable assessors to determine whether or not their library is compliant with the *Digital Library Reference Model* (DLRM), to enable those designing a new digital library to determine whether or not their planned library application is compliant with the DLRM, and to make it feasible for those who would like to use a digital library to hold their content, as a resource, or for any other purpose to establish its compliance. The structured nature of the checklist reduces ambiguity, a common aspect of assessments of this kind. Within the realm of digital libraries The *Digital Library Reference Model* delivers a common vocabulary and model to communication about digital libraries and their characteristics. The DL.org Checklist supports assessment of compliance of digital libraries and systems with the model and comparisons between different digital libraries.

Scope and Beneficiaries of the Checklist

This checklist has been designed to be used by assessors, from a system designer to a digital librarian or from a funder to a digital library content contributor who seeks to determine whether or not their digital library, or a specific digital library service or system, conforms to the *Digital Library Reference Model* (DLRM). It will help DL designers involved in building new digital library services or systems to assess whether or not their design will deliver a digital library management system that conforms to the DLRM. The checklist will allow an auditor (or researcher) to internally or externally assess information systems - which claim to be digital libraries - for conformance with the DLRM. Digital Library depositors and users will be able to make their own assessments with the checklist. It is expected that these roles overlap. While we intend that the users of the checklist should be varied we recognise that only staff (or auditors) with broad access to the digital library at several core levels will be able to complete all the checklist sections, and that a complete assessment will require the participation of more than one DL actor.

There will be many ways to use results of applying the checklist. For instance, a registry of assessed digital libraries might be created and maintained to make available the conformance checklist results; such a registry would help policy makers and DL managers to identify the key steps towards the implementation or development of a digital library, or even specific components or services to strengthen and innovate. Alternatively, DL Designers might use the Checklist in an inspirational way to test whether or not the DL that they are proposing developing conforms to the model.

The checklist – in conjunction with the *Digital Library Reference Model* – can also be used as an educational tool; the process of employing the *Digital Library Reference Model* requires the user to ask questions and to develop an appreciation of the Reference Model's attributes and subtleties. With the checklist in place, teachers will be able to use it in conjunction with the DLRM to enable students to study different digital libraries and to develop an understanding of their attributes and their processes.

Criteria

The checklist criteria were derived from the *Digital Library Reference Model* concepts and relationships structuring those requirements into groups of properties which were seen to be either mandatory, recommended, or nice to have. In listing them as criteria, we considered domain-related concepts and relationships within each domain and cross-domains. The checklist

does not have a one to one correspondence with the *Digital Library Reference Model*, but it does link each criterion that it has included to the model itself.

The criteria development process involved the identification of:

- “essential” features, i.e. characteristics that a ‘digital library’ must have (<MUST>). The “must” criteria is mandatory for any ‘digital library’;
- features that characterize “good” ‘digital libraries’ (<SHOULD>). The “should” criteria is a good practice according to the *Digital Library Reference Model*;
- “optional” features (<MAY>). The “may” criteria is related to property that can distinguish a ‘digital library’ from another one. These characteristics make a ‘digital library’ more appropriate to one purpose or another or add unique functionality to it.

The selected set of criteria results from an analysis of the DL Reference Model concepts and relationships. These criteria have been selected because of their discriminating power with respect to defining whether a ‘digital library’ conforms to the characterisation of such systems as envisaged by the *Digital Library Reference Model*. The presentation of the criteria is structured according to the six DL system characterising domains for the sake of usability and interoperability between the Checklist and the model:

- *Content-oriented criteria*
- *User-oriented criteria*
- *Functionality-oriented criteria*
- *Policy-oriented criteria*
- *Quality-oriented criteria*
- *Architecture-oriented criteria*

Survey of the State-of-the-Art of Research and Practice in Interoperability in Digital Libraries

An extensive Survey of the state-of-the-art of research and practice in interoperability in Digital Libraries was conducted during the first period of the Project. The aim of this survey was to provide a clear understanding of the current status in DL technology and research with regard to approaches for specific interoperability issues that belong to the six DL domains (as they have been defined in the DELOS DL Reference Model) i.e. content, user, functionality, quality, policy, and architecture. The survey was instrumental for several other activities that have been carried out in the frame of DL.org Project, in particular the production of the “Digital Library Technology and Methodology Cookbook”.

In the following we briefly outline the main results of this The State-of-the-Art Survey. First, some basic definitions of DL interoperability (but also interoperability in general) as well as the definitions of ten levels of interoperability are given. Then, six sections are dedicated to the detailed presentation of interoperability issues in each of the six domains. The collection of these issues is the result of the discussions among the experts in the Working Groups but it also reflects issues contained in the pertinent scientific literature. Solutions to the identified issues are

also introduced. These are either already implemented by projects or the result of a "greenfield - approach" by the Working Group experts. Each domain section closes with a summary description of the discussed issues and some concluding remarks. In particular:

Content Interoperability.

The *holdings* of the digital library has been a core characterizing aspect of digital libraries since their early conception. The types of information objects maintained over the time have evolved a lot from traditional "textual documents" through to multimedia ones and, more recently, to live objects (e.g. sensor readings) or dynamic query results. In the meantime, pushed the demand for powerful and rich digital libraries able to support a large variety of interdisciplinary activities, sharing and re-use of content has become a major need. Solutions for enabling digital library systems interoperability with respect to the use of this content have consequently become even more important than in the past. This section contributes to the definition of appropriate solutions by describing the issues involved in dealing with the interoperability of a selected set of information object characterizing properties (**Information Object Identifier, Structure, Metadata, Context, and Provenance**) and by presenting the approaches proposed by existing systems and in the literature for supporting system interoperability with respect to these information object properties.

User Interoperability:

This section dealt with "*interoperability of Digital Libraries (DLs) and Digital Library Systems (DLSs) with respect to what is captured in each DL or DLS about a user*". User-level interoperability of DLs arises with respect to issues such as user modeling, user profiling, user context, and user management. Issues related to another type of interoperability, the interoperability between users have also been identified. Although probably not in the original intention of the project, the concept of "interoperability of Users" per se is very important and has been examined. Interoperability between actors through their use of the DL is related to user-to-user interactions and includes mostly issues of collaboration and participation in the context of the DL as well as preservation of user privacy.

In this survey, a first identification and evaluation of existing approaches for the user-level interoperability issues have been provided. The User part of the survey is organized in the following way. First, some definitions of the "User" or "Actor" concept are provided along with the definition from the Reference Model. Furthermore, the interoperability levels that are associated with user interoperability as well as a summary of the identified interoperability issues are provided.

In particular, interoperability definitions, levels, approaches, and solutions concerning the characterizing aspects of user (**modeling, profiling, context, and management**) are provided.

In addition, interoperability definitions, levels, approaches, and solutions concerning another set of characterizing aspects of user (collaboration, participation, privacy) are provided.

Functionality Interoperability:

The interoperability issues concerning "functionality" that have been identified and prioritized spawn across several aspects which include core traits and properties of the domain e.g. **interface descriptions and process specifications**. These issues have been highlighted and (partially) addressed by several research communities e.g. Service Oriented Computing domain.

The goal of this Survey is to provide an insight on the issues and the approaches that may be used both for their representation and their anticipation.

Nevertheless, in order to properly address the interoperability issues pertaining to the functionality domain one should first try to define the notion of 'function interoperability' and its boundaries. A set of definitions for the notion of function interoperability have been provided. A list of identified issues along with solutions that may be applied for their anticipation has been provided. It includes: **Function API/Interface, Pre/Post Condition, Behavior, Composition, and Ontology/Taxonomy** issues.

These issues are first defined and then described in terms of modelling approaches, related interoperability levels and solutions.

Policy Interoperability

In this section an investigation of the interoperability requirements between digital libraries with respect to policies is presented. First an evaluation of existing approaches and best practices in relation to interoperability requirements and policies for digital libraries is provided. The starting point for this investigation has been the DELOS Digital Library Reference Model. However, the organisational context within which a digital library exists (currently not represented in the Reference Model), and the policies outside the traditional digital library's domains and disciplines, such as computer science theory, digital content management, data management, e-science, risk assessment and digital repository certification, health care and medical sector, Open Access Initiative were considered.

In particular, in this section a policy interoperability definition is given and several policy interoperability levels have been identified. In addition, the areas in which policies for digital libraries are needed have been identified. They include: access, acquisition, administration and management, cooperation, digital preservation, disposal, dissemination (Open Access), distributed system and network management, reference, security and privacy, personnel and staffing, and Internet policies for users.

Finally, four main policy categories were identified: (i) **Organization, Environment and Legal**, (ii) **Community and Usability**, (iii) **Process and Procedure**, and (iv) **Technology and Infrastructure** Policies.

Quality Interoperability

In this section an investigation of the interoperability requirements between digital libraries with respect to quality is presented. An evaluation of existing approaches and best practices in relation to quality interoperability is provided. The starting point for this investigation has been the DELOS Digital Library Reference Model. However, the organisational context within which a digital library exists (currently not represented in the Reference Model), the digital library evaluation studies outputs and the scientific literature findings on DL quality were considered.

It is recognized that a quality interoperability framework is needed to allow DLs to interoperate. In this regard, investigating quality interoperability means taking into account the several definitions of quality (what and how to measure), the different approaches to quality (e.g. quality of content, quality of services, quality of policies), the DL organisational context, in order to provide a common framework and a common vocabulary to share a common understanding on DL quality issues. This would help the comparison between the current solutions adopted, encouraging interoperability.

In particular, in this section a quality interoperability definition is given and several quality interoperability levels have been identified. In addition, the main research areas relevant for DL quality and quality interoperability were identified. They include: **data quality, quality parameters, and DL evaluation**. In addition, a quality parameter pattern that is considered to be the most characteristic for Digital Libraries was identified. This pattern, the **Quality Core Model**, is intended to help Digital Libraries to interoperate in the Quality domain.

Architecture Interoperability

According to the DL Reference Model, Architecture is one of the six domains characterizing the Digital Library universe. In particular, it is the domain dedicated to capture the "systemic" aspects of the two software systems playing a role in the Digital Library universe, i.e. the Digital Library System and the Digital Library Management System. The main concept characterizing this domain is the **Architectural Component**. An Architectural Component is any constituent of a software system implementing one or more Functions and concurring to implement either a Software Architecture or a System Architecture. In this section, the modeling issues regarding the Architectural Component Profile as well as the interoperability levels and solutions for Architectural Component Profiles are described.

In addition, the notion of **Application Framework** is introduced. Software Architecture and the System Architecture constituents have been conceived to work within the context of an application framework. The framework captures component roles, component-to-component interaction patterns, and prescribes interfaces and protocols to which components should conform in order to interact (exchange information). For example, systems component conceived to operate with the support of a Registry can be successfully reused in a scenario providing them with the same support. Understanding the framework of a component is a necessary prerequisite for being interoperable with it. A detailed description of the current approaches for Application Framework modeling and interoperability levels and solutions is given.

Interoperability Framework

One of the main difficulties affecting the interoperability domain is the lack of a common framework that can be used to characterize – in a systematic way – the problem facets as well as the existing and forthcoming solutions and approaches. During the first period of the Project an **Interoperability Framework** has been defined. The several DL interoperability problems, solutions and best practices identified and addressed by the Project Working Groups were described according to the guiding principles of this Framework and included into the Digital Library Technology and Methodology Cookbook.

The IEEE Glossary defines interoperability as “*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*”. This definition highlights the fact that in order to achieve interoperability between two entities (provider, consumer) two conditions must be satisfied: (i) the two entities must be able to exchange information and (ii) the consumer entity must be able to effectively use the exchanged information, i.e. the consumer must be able to perform the tasks it is willing to do by relying on the exchanged information.

By having this definition as a firm starting point, the following three constitutive concepts of the Framework were identified and defined:

- **interoperability scenario**, i.e. the settings where interoperability takes place;
- **interoperability issue**, i.e. a problem hindering an interoperability scenario;
- **interoperability solution**, i.e. an approach aiming at removing an interoperability issue to achieve an interoperability scenario.

An **interoperability scenario** occurs whenever the following conditions manifest:

- there are *at least two entities* that have to cooperate in the context of the scenario, one of the entities is playing the role of **Provider** while the other one is playing the role of **Consumer**;
- the cooperation consists in a **Consumer** willing to exploit a certain **Resource** – owned by the **Provider** – to perform a certain **Task** – the work the **Consumer** is willing to do by relying on that third party **Resource**;
- to make the scenario feasible the two entities should be able to *exchange “meaningful” information*. There can be no exchange of information without a **communication channel** and a *protocol* regulating the channel functioning, i.e. a medium enabling information exchange and some rules governing its effective use to pass information among entities. There can be no information without some form of **representation**, i.e. information is “carried by” or “arises from” a representation. The *meaningfulness* of the information depends on the **Resource** and the **Task** characterizing the scenario, i.e. the **Resource** should satisfy the **Consumer** needs and the **Consumer** should acquire the information on the **Resource** that is required to perform the **Task** (**Task preconditions**);
- the operation of each entity, either **Provider** or **Consumer**, depends on **Organisational**, **Semantic** and **Technical** aspects.

Organisational aspects capture characteristics of business goals and processes of the institution operating the entity. Examples of organisational aspects are the type of policies governing Information Objects consumption, the type of functionality to be exposed to Consumers, the quality of service to be supported with respect to a specific functionality.

Semantic aspects capture characteristics of the meaning of the exchanged digital library resource as well as of the rest of information exchanged through the communication channel. Examples of semantic aspects are the meaning assigned to a certain policy, the meaning assigned to a certain quality parameter, the meaning assigned to a certain value in a metadata record.

Technical aspects capture characteristics of the technology supporting the operation of the entity as well as of the communication channel and the information exchanged through it. Examples of technical aspects are the DLMS used to implement the Digital Library, the protocol used to expose a certain function, the encoding format of an Information Object. It is important to notice that these three levels influence each other in a top-down fashion, i.e. organizational aspects set the scene of the entire domain characterizing its scope and its overall functioning, semantic aspects define the meaning of the entities involved in the domain according to the organizational aspects, technical aspects have to put in place / implement the organizational and semantic aspects.

An **interoperability issue** occurs whenever the Task preconditions are not satisfied. Task preconditions are not satisfied whenever Consumers’ expectations about the Provider Resource

in the context of the Task to be performed are not met by the settings of the scenario, i.e. the technical, semantic and/or organizational aspects characterizing the Provider and the Consumer regarding the Resource and the Task are not compatible. Exemplars of interoperability issues include: the format used by the Provider to represent an Information Object differs from the format expected by the Consumer to support a processing activity; the interface through which the Information Object access function is supported by the Provider differs from the one the Consumer is expected to use for content fetching; the semantic of the search function implemented by the Provider is different from the semantic the Consumer aims at relying on to support a cross system search; the Policy governing Information Object consumption supported by the Provider are different from the Policy expected by the Consumer.

An **interoperability solution** is an approach reconciling the differences captured by an interoperability issue. It is based on a generic **transformation function** that conceptually acts at any of the levels characterizing Provider and Consumer interaction – organisational, semantic and technical – to make Provider characteristics and Consumer needs uniform. Such transformation function may act on Provider characteristics or on Consumer needs as well as on both. Exemplars of interoperability solutions include: the transformation and exposure of metadata objects through the harvesting protocol and format expected by the Consumer, the implementation of a search client based on a search interface specification implemented by the Provider, the implementation of policies client-side and server-side to guarantee the agreed quality of service on a distributed search operation.

Digital Library Technology and Methodology Cookbook

The demand for powerful and rich Digital Libraries able to support a large variety of interdisciplinary activities as well as the data deluge the information society is confronted with nowadays have increased the need for ‘*building by re-use*’ and ‘*sharing*’. Interoperability is a central issue to satisfy these needs. Despite its importance, and the many attempts to resolve this problem in the past, existing solutions are, however, still very limited. The main reasons for this slow progress are lack of any systematic approach for addressing the issue and scarce knowledge of the adopted solutions. Too often these remain confined to the systems they have been designed for. By relying on the DELOS Digital Library Reference Model as foundational conceptual framework, the “Digital Library Technology and Methodology Cookbook” aims at overcoming this gap. In particular, it introduces a common interoperability framework (presented in detail in “An Interoperability Framework” above) and then it collects and describes through it a portfolio of best practices and pattern solutions to common issues faced when developing large-scale interoperable Digital Library systems. The solutions presented are organised according to the Reference Model domains to which the Resource they refer to belong, i.e., content, user, functionality, policy, quality and architecture. Each interoperability solution description is structured as follows:

- **Overview:** a description of the context of the proposed item including a characterisation in terms of the Interoperability Model / Framework and providing the reader with pointers to extensive descriptions of it;
- **Requirements:** a description of which settings for *Organisational*, *Semantic* and/or *Technical* aspects should occur in order to make it possible to use the solution;

- **Results:** a description of the changes resulting from the exploitation of the solution in *Organisational, Semantic* and/or *Technical* aspects;
- **Implementation guidelines:** a description of how the solution has to be implemented;
- **Assessment:** an evaluation of the quality of the proposed approach including an estimation of its implementation costs and effectiveness.

The Cookbook also includes a number of common and challenging interoperability scenarios faced when building large scale digital libraries and the concrete approaches put in place to resolve them. These scenarios combine in a coherent way the approaches and more basic solutions illustrated in the previous part. The Cookbook ends by reporting a glossary of terms related to interoperability and digital libraries.

Networked International Digital Library Community

Working Groups: six Working Groups (Content, User, Functionality, Policy, Quality, Architecture) have been established. These WGs are composed of internationally recognized experts representing relevant Digital Library initiatives, organizations, and projects. The total number of external experts from these groups amounts to 32.

Liaison Group: 18 international experts have formed the DL.org Liaison Group.

27 European initiatives: ASSETS (Advanced Service Search & Enhancing Technological Solutions for the European Digital Library), CASPAR, CHORUS+ - Audio-visual Search, D4Science, DARIAH (Digital Research Infrastructure for the Arts & Humanities), DC-Net (Digital Cultural Heritage NETwork), DILL (Digital Library Learning – DILL), DRAMBORA (Digital Repository Audit Method Based On Risk Assessment), DRIVER-II, ENVISION (ENVironmental Services Infrastructure with ONtologies), EU-Provenance, Europeana, EuropeanaConnect, European Film Gateway, EUScreen, GRDI2020 – Towards a Vision for Global Research Data Infrastructures, HOPE (Heritage of the People's Europe), LIFEWATCH - eScience & technology infrastructure for biodiversity data & observatories OGF-Europe – Digital Repositories Group for Distributed Computing, OpenAIRE (Open Access infrastructure for Research in Europe), Papyrus, PLANETS, Scientix – The Community for science education in Europe, SHAMAN (Sustaining Heritage Access through Multivalent Archiving), STERNA (Semantic Web-based Thematic European Reference Network Application), TrebleCLEF (Evaluation, Best Practices and Collaboration for Multilingual Information Access), VENUS-C (Multidisciplinary Environments Using Cloud Infrastructures).

External Organizations: 16 External organizations (DLF, CNI, OGF, EDL, DELOS Association, DPC, E-LIS, NDHA, SIMILE, DANS, DCC DIFFUSE, INTERNET ARCHIVE, NSDL.org, OAI, DILL Master Program) were involved in the activities of the DL.org activities.

MoUs: 10 MoUs between DL.org and European projects and initiatives have been signed (D4Science, EFG, TrebleCLEF, CAB, Drambora, Papyrus, Sterna, Europeana V1.0, DRIVER II, DC-NET).

Networking Session: An ICT2010 Networking session on “Global Information Infrastructures for Science & Cultural Heritage: The Interoperability Challenge” (Brussels, 29 September 2010) was organized in collaboration with two other EU projects (DC-NET, GRDI2020).

Parma Seminar: The Seminar on Research and Education in Digital Libraries was co-hosted with the Digital Library Learning international Master Programme funded by the EC’s Erasmus Mundus and took place on 9 November in Parma, Italy. A follow-up workshop will take place **European Library Automation Group (ELAG 2011)**, 25-29 May 2011, Prague, Czech Republic.

Athens Workshop: The Workshop on Theory and Practice in Digital Libraries: A European Approach, which took place on 13 December 2010 in Athens, leveraged an alliance with the Veria Central Library and the Ionian University with their strong links to the LIS community.

DL.org modules on Wikiversity: alliance with Virginia Tech and Library & Information Science Graduate School, University of North Carolina at Chapel Hill in that it has helped to shape and deliver a set of training modules now published on Wikiversity, which has ensured education on Digital Libraries stemming from DL.org is widely available.

“Conceptual frameworks, models, theories, definitions” module included in the Digital Library Curriculum Project (part of the Wikiversity initiative)

A module “Conceptual frameworks, models, theories, definitions” has been produced, in collaboration with the Virginia Tech University, and included in the Digital Library Curriculum Project which is part of the Wikiversity initiative.

The scope of this module is an introduction to several conceptual models characterizing the DL domain (Digital Libraries Reference Model-DLRM, 5S, DELOS Classification and Evaluation Scheme, CIDOC Conceptual Reference Model, DOLCE-based Ontologies for Large Software Systems).

More specifically, the learning objectives are to provide the students with a high level yet comprehensive knowledge of several conceptual frameworks and models, to provide them with a unifying and extended terminology, and an overall scheme helping to classify further readings.

The module includes a description of: the “Digital Libraries Reference Model”, the 5S Framework, the CIDOC Conceptual Reference Model, and the DOLCE-based Ontologies for Large Software Systems. The DELOS Classification and Evaluation Scheme, and the comparison between The reference Model and 5S.

Five DL.org Workshops

**“Digital Library Interoperability: Best Practices and Modeling Foundations”
1 October 2009, Corfu (Greece)**

Aim: The main objective of the first DL.org Workshop was to present the first Project findings concerning the interoperability problems faced by the Digital Libraries to the wide Digital Library community.

Outcome: Publication of the 1st DL.org Workshop Booklet. Publication of position papers provided by Workshop attendants. Report on the First DL.org Workshop on “Digital Library Interoperability: Best Practices and Modelling Foundations”, DLib Magazine, November/December 2009, volume 15 11/12, ISSN 1082-9873.

**“Making Digital Libraries Interoperable: Challenges and Approaches”
9-10 September 2010, Glasgow**

Aim: The Workshop addressed the different aspects involved in achieving DL interoperability, from conceptualization at a high organizational level to instantiation at process level, as well as to modeling techniques for representing and enabling interoperability between heterogeneous Digital Libraries, mediation approaches, methods, and supporting systems.

Outcome: The main outcome is the publication of the Proceedings by Springer in the “Communications in Computer and Information Science” series.

**“Research and Education in Digital Libraries”
9 November 2010, Parma, Italy**

Aim: The objective of this Workshop was to explore ways of ensuring closer co-operation between the findings and outputs of DL.org and the wider research and educational communities. Mechanisms for exchanging, sharing and integrating research results into education in digital libraries were also discussed.

Outcome: As an outcome of this event, plans for possible future collaborations were established both in terms of potential contributions to the DL.org Cookbook and Reference Model and in terms of tailoring these products to the need of the education sector.

**“Theory and Practice in Digital Libraries: A European Approach”
13 December 2010, Athens, Greece**

Aim: Forge an alliance with national institutions and European initiatives of relevance to DL.org, provide a conceptual framework on the reference model, underscore the value of the Cookbook and offer interactive sessions for hands-on experience of real-world digital libraries.

Outcome: Alliances forged with the Veria Central Library and its stakeholder community of librarians, as well as with the Ionian University. Demo Session featuring Europeana, TEL/TELplus, AccessIT (training on DLs), Driver/OpenAIRE and D4Science. Position statements from participants the need for future educational activities for DLs and also the importance of DLs in collecting, preserving and disseminating cultural heritage among different countries of Europe, the need for both more collaborative and technically focused workshops, and the importance of providing examples of how theory is implemented in practice

“Digital Libraries and Open Access: Interoperability Strategies”
4 February 2011, London, UK

Aim: Trigger the multi-disciplinary debate about research on Digital Libraries and Open Access. Discuss DL.org project results, and existing frameworks and best practices for interoperability within the communities of practice. Propose common strategies for interoperability: start discussing how to implement a mechanism for exchanging, sharing and integrating results between DLs and OARs communities. Create new connections and partnerships, and explore ways for a closer cooperation between researchers and the communities of practice.

Outcome: providing insights into the DL current state of the art with emphasis on the DL.org outputs, the outcomes of DL.org surveys targeting Open Access Repositories and underscoring the important role of policy and quality. Shedding light on key issues surrounding Open Access with perspectives from both Europe and the U.S. Exploring strategies for interoperability with examples from European and international initiatives, as well as top-level challenges surrounding data management.

DL.org Autumn School on “Digital Libraries & Digital Repositories: Interoperability Perspectives”

An Autumn School on “Digital Libraries & Digital Repositories: Interoperability Perspectives” has been organized in the first week of October in Athens. The consortium developed the scientific program and the budget plan for the school and also took care of organisation and logistical issues (invitations delivery to both, speakers and potential participants, proposition of bursaries, venue arrangements etc.). Updates on the school were regularly presented over the DL.org website and multiple press announcements have been released and sent to professional targeted mailing lists (Web4Lib, ABDS-INFO, LIS-UKEIG, AIB-CUR, Lista Archivi 23, SWISS-LIB, ERIL-L, IFLA DIGLIB, LIBER).

The School brought together twelve European students from France, UK, Italy, Lithuania, Bulgaria and Greece, with cross-disciplinary backgrounds and expertise (librarians, DL managers, DL designers and Software developers) to gain insights into digital libraries and digital repositories along the perspectives of content, functionality, users, policy, quality and architecture, the six core domains captured in the DL.org DL Reference Model. Those insights have been linked to the interoperability challenge from technical, semantic and organisational perspectives.

The Autumn School was highly rated and from both a scientific and organisational point of view it has been very successful. The feedback collection from the participants and lecturers included aspects such as: underscoring the performance of the event in general and the background material, expressing expectations, and addressing organisational aspects. All participants expressed their interest attending similar events in the future. Here is how the Autumn School fared out of a total score of 5: speaker effectiveness: 4.41; structure of the event: 4.5; value of background documentation: 4.45; organisation: 4.83 and addressing the main topic: 4.58

2.4 Potential impact (including the socio-economic impact and the wider societal implications of the project so far)

DL.org has significantly contributed to Digital Library development, education and research, working towards interoperability as a foundation for current and future digital library initiatives. DL.org has been instrumental in fostering collaboration between experts, offering a good example of best practices where core values are grounded in close co-operation and openness to share knowledge and learning among stakeholders. The potential impact and exploitation of results stems chiefly from new findings, knowledge and competence-building which DL.org has fostered by placing emphasis on best practices, and by harnessing global expertise and mobilizing communities of practice. Outcomes of DL.org have thus been designed for the benefit of the digital library community and the exploitation of its results has been a central activity for the project. Partners have undertaken a concerted effort so that important outcomes reach wider audiences and empower target groups addressing current and future challenges.

2.4.1 Impact areas

In a world where information is becoming more and more central and where the importance of information sharing is starting to be recognised, interoperability has become a key challenge for the future as testified by its inclusion in the Actions list of the Digital Agenda For Europe (http://ec.europa.eu/information_society/digital-agenda/index_en.htm):

Action 24 of the Digital Agenda : Adopt a European Interoperability Strategy and Framework

“We need effective interoperability between IT products and services to build a truly digital society. The internet is the best example of the power of technical interoperability. Its open architecture gave interoperable devices and applications to billions around the world. But to reap the full benefits of ICT deployment interoperability between devices, applications, data repositories, services and networks must be further enhanced.”

By addressing interoperability DL.org has had a considerable impact in, at least, the four different areas:

Impact in the Scientific Area

The DL Reference Model and the Interoperability Framework, introduced as part of the Technology and Methodology Digital Library Cookbook, provide solid foundations for scientific systematization of the DL domain. These artifacts have received considerable attention by the participants in all the five scientific events organised by the project and, more general, by the DL.org community. Until now they have laid the ground for more than 20 scientific papers published in the two year lifetime of the project.

Impact in the Educational Area

DL education is growing, so more eLearning programmes will be needed alongside innovative ways of delivering courses. More stronger theoretical foundation basis and increased binding between research and education is needed to support this growth. The DELOS Reference Model has been used in different University courses, like the for example those organised by the International Master Digital Library Learning programme (DILL), since its inception. In the future the Reference Model and the Technology Cookbook might become the basis for a focused teaching material for Digital Library specialized courses. Its role might also become more important should the International PhD Digital Library Learning programme programme be approved. It is expected that the module contributions hosted on the Digital Library section of Wikiversity, in synergy with the U.S. Digital Library Curriculum Development, can further contribute to maximise this type of impact.

Impact in the Library Area

DL.org has provided at least three important contributions to the Library area:

- The Reference Model and the Technology Cookbook have highlighted core concepts, like policies and quality, which have been not explicitly digitally represented until now in the library framework despite they permeate most of the (digital) library operations. The recognition of the importance of such representation is an relevant achievement and provides a stimulus for introducing shared models and standards for it.
- The Reference Model Conformance Checklist offers a practical tool for assisting auditors in: (i) assessing compliance of developed systems with digital libraries, (ii) better characterising their capabilities and (ii) reporting to the funding agencies in charge of gauging Return on Investment.
- The organised events and the major project artifacts have given the opportunity to many librarians and information scientists to understand how a physical library can be linked with the digital one and how the library theory and concepts are implemented in practice.

Impact in the Digital Library Application Area

The Digital Library Reference Model and the Technology and Methodology Cookbook are important tools for the Digital Library system developers. Starting from the Reference Model, Reference Architectures can be defined which guide the development or enhancement of digital libraries in compliance with the model. The model proposed has been already exploited in defining the architecture of a number of systems developed in the context of EU projects. It has also provided input for other similar attempts in other areas, e.g. the LifeWatch Reference Model² in the biodiversity area.

The Technology Cookbook has brought into sharp relief best practices and current solutions for interoperability with the aim of avoiding duplication of efforts. Reuse of software and solutions is a pressing demand in the DL and related areas (see for example objectives of the

² http://www.lifewatch.eu/index.php?option=com_content&view=article&id=93&Itemid=18

Interoperability WG in the context of the Coalition of Open Access Repositories (COAR)³). DL System designers and developers that have to face DL interoperability issues, can find in the Cookbook most relevant solutions classified according their applicability and purpose. Moreover, by exploiting the Interoperability Framework introduced in the Cookbook, they can systematize the problem and understand which solutions better fit their needs. Until now this framework has been validated in the context of a number of federated DL and similar systems, like EFG, HOPE, D4Science, and OpenIARE.

2.5 Main dissemination activities and exploitation of results

2.5.1 Outreach activities

DL.org has significantly contributed to Digital Library development, education and research, working towards interoperability as a foundation for current and future digital library initiatives. DL.org has been instrumental in fostering collaboration between experts, offering a good example of best practices where core values are grounded in close co-operation and openness to share knowledge and learning among stakeholders. The potential impact and exploitation of results stems chiefly from new findings, knowledge and competence-building which DL.org has fostered by placing emphasis on best practices, and by harnessing global expertise and mobilizing communities of practice. Outcomes of DL.org have thus been designed for the benefit of the digital library community and the exploitation of its results has been a central activity for the project. Partners have undertaken a concerted effort so that important outcomes reach wider audiences and empower target groups addressing current and future challenges.

The exploitation efforts were based on an approach established in the first year of the project, and which defines three levels for the exploitation strategy: the scientific, the educational and the knowledge transfer level. Targeted activities addressed all three levels. The meetings and workshops organised, dealt with demanding research issues related to Digital Libraries interoperability and facilitated a structured scientific exchange on the topic. The same holds for the papers and presentations prepared by the consortium members and the members of the Working Groups, which tackled different aspects of Digital Libraries interoperability. Efforts were also intensified in order to throw into sharp relief the educational dimension, especially of the Digital Libraries Reference Model. For this reason dedicated events have been organised, even in the framework of Master Programmes with special emphasis on students as the next generation of developers and providers. Moreover, the Reference Model has served as the basis for DL.org's contribution to the Wikiversity learning material on Digital Libraries which is online available. Finally, the project partners and the members of the Working Groups have acted as mediators by disseminating and transferring knowledge created within the project to application and user communities in the field of DLs.

Outputs serving target communities for sustained impact

³ <http://coar-repositories.org/>

The outputs of DL.org can only gain value by serving the real-world needs of target communities, spanning a spectrum of professionals, such as librarians, information scientists, developers, educationalists, researchers and students at various stages in their academic careers. On a broader scale, DL.org outputs also need to serve auditors and funding agencies of digital libraries who can gauge compliance and the Return on Investment against the concepts and values captured by the DL.org Reference Model.

In order to cater to these diverse needs as effectively as possible, DL.org has expanded its original planned outputs – an enhanced and consolidated **Digital Library Reference Model** stemming from the DELOS Reference Model and a **Technology and Methodology Digital Library Cookbook** – to encompass four additional outputs, with the aim of:

- Guiding the development or enhancement of digital libraries in compliance with the DL.org Reference Model.
- Assisting auditors in assessing compliance and funding agencies in gauging Return on Investment.
- Bringing into sharp relief best practices and current solutions for interoperability with the aim of avoiding duplication of efforts. One DL.org testimony has described the Cookbook as “*a powerful tool for sharing and managing knowledge*”, Marcial Batiancila, Master Student of the Digital Library Learning programme funded by the EC’s Erasmus Mundus.
- Supporting educational and research needs by combining a grounding in conceptual frameworks with hands-on experience and demos of real-world examples.
- Guiding teaching-learning approaches and ensuring research outcomes inform learning material in the most effective way possible.

At the London Workshop in February 2011, a librarian from India, Sunil Gorla, stated “*The Reference Model and Cookbook are excellent tools for all the people associated in the field of digital libraries. These tools will be useful for both digital library developers as well as digital library system/software developers*”.

All DL.org outputs are available for free download on the project’s website, while the following are also available as printed publications:

DL.org Reference Model Check List. The aim is to guide developers, auditors and funding agencies in assessing the extent to which the solutions chosen comply with the DL.org Reference Model.
An abridged version of the DL.org Digital Library Manifesto forming part of the Reference Model. The aim is to provide a user-friendly introduction to the Reference Model and its conceptual framework.
An abridged version of the DL.org Reference Model – In a Nutshell forming part of the Reference Model. The aim is to facilitate an understanding of the conceptual framework.
An abridged version of the Technology and Methodology Digital Library Cookbook. The aim is to offer a user-friendly guide to current interoperability solutions.

Dissemination activities have focused on highlighting the main findings and outputs of the project in several ways:

- **Event organisation.** Two DL.org Workshops hosted with the 13th and 14th European Conference on Digital Libraries (ECDL2009 and ECDL2010, respectively). Three national events – Parma Seminar (November 2010), Athens Workshop (December 2010) and London Workshop (February 2011). Networking Session at ICT2010 co-hosted with two European initiatives, DC-Net and GRDI2020. A DL.org Workshop on Policy and Quality Interoperability. A Birds of a Feather session at OR2010.
- **Event presentations.** Twelve presentations at international conferences and workshops, covering each of the six concepts investigated by DL.org and its Working Groups.
- **Publications.** Five DL.org papers submitted through the Call for Papers for the 2nd DL.org Workshop will be published in *Lecture Notes in Computer Science* (LNCS), Springer, having met the criteria set in terms of international relevance and timeliness. In addition to this publication, fourteen papers have been published in conference proceedings or international journals.
- **Interviews and eNewsletters.** Interviews have been conducted with pioneers and professionals using DL.org outputs, whether as educationalists or master students embarking on a career in digital libraries. eNewsletters have covered these interviews, as well as event outcomes and promotion. Community messaging has also been in the form of single announcements to promote specific initiatives, alongside press releases and articles.

The project website serves as a key outlet for disseminating all the outputs and outcomes. Alongside the website, the Consortium has actively maintained a project blog and leveraged social networks to connect communities virtually, keeping them up to speed on the latest initiatives and developments.

In order to maintain momentum around DL.org achievements and further education on Digital Libraries, the project has:

- presented the enhanced version of the Reference Model at **THATCamp** (The Humanities and Technology Camp), 23-26 March 2011, Florence, Italy;
- successfully submitted a proposal for a workshop at the conference of the **European Library Automation Group (ELAG 2011)**, 25-29 May 2011, Prague, Czech Republic. The workshop is entitled Research and Education in Digital Libraries, building on the successful outcomes of the Parma Seminar on the same theme.
- successfully submitted a tutorial at the **Extended Semantic Web Conference**, 29 May-2 June 2011, Heraklion, Crete entitled DL.org Tutorial on Digital Libraries Foundations and Interoperability.

Education and Research on Digital Libraries

Two events hosted by DL.org have placed special emphasis on furthering education and research on digital libraries across the community of librarian professionals, system and software developers with the support of several Working Group members and by establishing a strategic alliance with the Digital Library Learning international master programme funded by the EC's Erasmus Mundus. The exploitation of the outcomes is not only facilitated through the project website resources but also through the post-project workshop and tutorial cited above.

Furthermore, DL.org has enabled the wide exploitation of the Reference Model in education and curricula development thanks to an alliance with the U.S. Digital Library Curriculum Development initiative with the collaborative efforts of Virginia Tech and the Library & Information Science Graduate School, University of North Carolina at Chapel Hill.

Autumn School, 3-8 October 2010, Athens, Greece

Lectures on reference modelling, interoperability challenges and the six core concepts alongside a demo showcase and student group presentations with nine Consortium members and five members of the Working Groups serving as lecturers and mentors. To encourage background knowledge prior to the Autumn School, students received a detailed Virtual Reading List, which remains available to the wider community through the project website.

Key learning outcomes include an appreciation of the issues surrounding interoperability within the context of institutions working with digital documents and data; a grasp of the core research in the area of digital library interoperability; a coherent and practical understanding of efforts focused on interoperability from organizational, technical and methodological perspectives; experience with issues surrounding digital library modelling and management; an understanding of the different approaches to the concepts of content, functionality, user, policy, quality and architecture; new knowledge on approaches to digital library and repository design and deployment; new knowledge on the techniques and practices underlying digital library management in relation to interoperability coupled with an understanding of how interoperability requirements can be integrated into approaches to digital library development.

All the resources from the Autumn School are publicly available on the website so as to underpin future educational activities. The high satisfaction scores from participants perfectly illustrate not only the educational value add of the Autumn School but also its potential exploitation in the future, ensuring the acquisition of new knowledge and competencies that are key to taking digital libraries to the next level. A selection of Autumn School comments bear testimony to the valuable role of physical training events grounded on effective programme development combining a lessons on the conceptual framework with hands-on experience alongside competent lecturers.

“The organisation into the various fundamental “domains”, how they have been treated and explained to us, so as to understand the essential importance and role of each of them to achieve interoperability is what I liked best. Useful theoretical as well as practical references to promote some Digital Libraries ideas for future projects in my organisation is what I am take back with me.”

“Collaboration by working on problem solving solutions, the participation of the speakers during the lessons and presentations scenarios based on real-life cases is what I liked best. Additional practices solutions and best methods in order to organise or reorganise digital libraries and repositories is what I am taking away with me.”

“What I liked most was the D4Science demo, bringing a different perspective. For me the main take-away is new knowledge on conceptualisation and generalisation of Digital Library model, as well as interoperability guidelines.”

“I really liked the extensive and thorough presentation of all aspects of Digital Libraries, Digital Library Systems and Digital Library Management Systems. I take back with me new know-how on the DL.org Reference Model and the Cookbook.”

Seminar on Research and Education in Digital Libraries, 9 November 2010, Parma, Italy

The alliance forged with the Digital Library Learning (DILL) master programme enabled DL.org to engage with a truly international audience of young librarian professionals and European educationalists in the field. The Reference Model has been used in DILL since its inception, a clear indication of its role in educational programmes.

Main outcomes from the Seminar include gaining an understanding of how DL.org findings and outputs on interoperability could be transferred to education in digital libraries; defining new research topics of most value to PhD students in order to facilitate the integration of research both in European projects and academic research; understanding how a pan-European mechanism for exchanging and sharing research results for educational purposes could be implemented. The Seminar demonstrated that research and education have much to gain from working more closely together to ensure research findings are shared and applied in educational programmes. It also highlighted potential new opportunities if the DILL PhD programme is approved. In such a scenario, binding together research and education would be crucial while also offering clear exploitation potential for DL.org findings, outputs and publications. Continued liaison with master and PhD curricula developers is key to furthering the outcomes of DL.org by building new competences, enhancing programmes by analyzing the educational needs of digital library professionals, guiding teaching-learning approaches and ensuring research outcomes inform learning material as effectively as possible. Good examples of on-going liaison include the workshop in May 2011 and the support of the investigations conducted by the DILL master student, Marcial Batiacila.

DL.org Modules on Digital Library Section of Wikiversity

Building on the successful outcomes of the Autumn School, Parma Seminar and liaison with Working Group experts, DL.org has ensured the long-term exploitation of the Reference Model from an educational perspective through the modules hosted on the Digital Library section of Wikiversity. The modules form part of the curriculum topic entitled **Conceptual Frameworks, Models, Theories, Definitions**.

The modules, which are available at http://en.wikiversity.org/wiki/Digital_Libraries, are designed to provide a conceptual framework and models that are comprehensive in scope and grounded on unified terminology, while the overall schema aims to facilitate further reading and analysis. The introduction to the modules places emphasis on the role that reference modelling plays in the digital library space with overviews of core conceptual models spanning the DL.org Digital Library Reference Model; Streams, Structures, Spaces, Scenarios and Societies (5S), a unified formal theory for Digital Libraries; the DELOS Classification and Evaluation Scheme; CIDOC Conceptual Reference Model and DOLCE-based Ontologies for Large Software Systems. The reference section includes pointers on a large selection of recommended reading material while a set of exercises aim to motivate learning and self-assessment.

European initiatives at the forefront of digital library innovation & interoperability efforts

Of the 40 Strategic Alliances forged across European initiatives, national initiatives, think tanks and coalitions over the project life-time, 27 are initiatives funded by the European Commission while 5 are EU27 national initiatives, placing the European Union at the forefront of knowledge exchange, which is key to mobilizing and educating the digital library community, as well as ensuring economies of scale by encouraging cross-fertilisation and avoiding duplications of effort. Fifteen and twelve alliances with European initiatives have been forged in year one and two of the project respectively, representing six Directorate General Units of the European Commission plus two projects supported by the European Strategy Forum on Research Infrastructures (ESFRI), cutting across many pillars and disciplines of the 7th Framework Programme.

The national initiatives from EU27 countries include Data Archiving and Networked Services (DANS) – Royal Netherlands Academy of Arts and Sciences (KNAW), Digital Curation Centre, UK, Italian Open Access Working Group (CRUI), Open Access Working Group of the Helmholtz Association, VERIA Central Library.

The contribution of European initiatives to DL.org has also been valued internationally. A good case in point comes from an external expert at the London Workshop:

“Policy makers in the U.S. are very interested in seeing what is happening in Europe. The London Workshop on Digital Libraries and Open Access has led to a webcast with representatives from OpenAIRE to support scholarly communication at academic institutions grounded on Open Access.” Heather Joseph, Executive Director of the Scholarly Publishing and Academic Resources Coalition (SPARC), U.S.

Digital Agenda for Europe 2020: Close interaction with DL.org experts has also pinpointed the value of The Digital Agenda for Europe - COM(2010) 245 – Brussels, 19.05.2010, particularly as regards the DL.org Technology and Methodology Cookbook. Topics of relevance include the Key Priority Areas set for interoperability, the connections between the certification/standardisation actions, cost-effectiveness, and Open Access solutions and the three levels of interoperability investigated, that is organizational, semantic and technical. These views have been captured by expert blogs available at <http://www.dlorg.eu/blog/?p=177>, <http://www.dlorg.eu/blog/?p=214> and <http://www.dlorg.eu/blog/?p=207>.

In summary, the achievements of DL.org at EU level have a strong exploitation and take-up potential by current and future initiatives and institutions developing digital libraries and addressing the interoperability challenge through free publicly available on the DL.org website and widely promoted through focused campaigns.

International Co-operation

Global expertise has been harnessed through the six Working Groups, the Liaison Group and the External Advisory Board. Strategic Alliances outside Europe span Digital Library Curriculum Development: Virginia Tech and the Library & Information Science Graduate School, University of North Carolina at Chapel Hill, the Digital Preservation Coalition, GRL2020, Memento, the

PLEDGE project supported by MIT Libraries Streams, Structures, Spaces, Scenarios and Societies (5S) and the National Digital Heritage Archive in New Zealand.

The U.S. is the most represented country in the Working Groups with experts from Virginia Tech, the New York State University at Buffalo, Stanford University, the U.S. Geological Survey Centre, MIT Libraries, Rutgers University, Fedora Commons and DuraSpace. Two of the three external advisors are also from the U.S., the National Science Foundation and Rice University. While the U.S. is also well represented in the Liaison Group with members from Internet Archive, Cornell University Library, Pittsburgh University, alongside the international Coalition for Networked Information, and Open Access Initiative – Object Reuse and Exchange, experts also come from the University of Queensland in Australia, the Indian Statistical Institute, Tsukuba University in Japan, the National Archives in New Zealand, the Russian Academy of Science, and the Nanyang Technological University in Singapore. DL.org has also exchanged knowledge with the U.S. Library of Congress, and the Scholarly Publishing and Academic Resources Coalition (SPARC) based in Washington DC. Additionally, the active DL.org community membership covers twenty-four countries around the world: Australia, Bangladesh, Belarus, Burundi, Canada, China, Colombia, India, Indonesia, Iran, Japan, Malawi, New Zealand, Nigeria, Pakistan, Philippines, Russian Federation, Saudi Arabia, Singapore, South Africa, Taiwan, Uganda, U.S., and Vietnam. The Parma Seminar played an important part in broadening the geographic scope of the community thanks to the attendance of international master students. Finally, the Consortium has close links with the international team of experts that have supported the GRL2020 initiative and a pool of contacts from the digital library space mainly in India. The value of DL.org's international outreach was captured during the 1st DL.org Workshop in October 2009:

“DL.org has brought together the leaders in this space, particularly in Europe and particularly in the U.S., but also from Asia and South Africa. Launching the conversation at places like this is incredibly important for people to interact together. This is by far the most comprehensive attempt yet to capture the whole space for DL research and development that needs to be done. I think it will become “the” forum for considering that.” Professor Ronald Larsen, Pittsburgh University.

Together, this consolidated network enables DL.org to ensure that its findings and outputs are shared internationally through focused messaging and the final promotional campaign. DL.org is also well placed to build on the close ties established in similar future initiatives and gatherings.

2.5.2 The project public website and relevant material

The Project Website

The project website has served as a key outlet for disseminating all the outputs and outcomes. Alongside the website, the Consortium has actively maintained a project blog and leveraged social networks to connect communities virtually, keeping them up to speed on the latest initiatives and developments.

Evaluating the impact of DL.org through the website illustrates significant increases across key metrics, ranging from number of visits to country spread. Figure 1 below shows the number of total visits from December 2009 to February 2011 with significant increases commencing in March 2010 with the launch of the new website, maintaining similar outcomes through to February 2011.

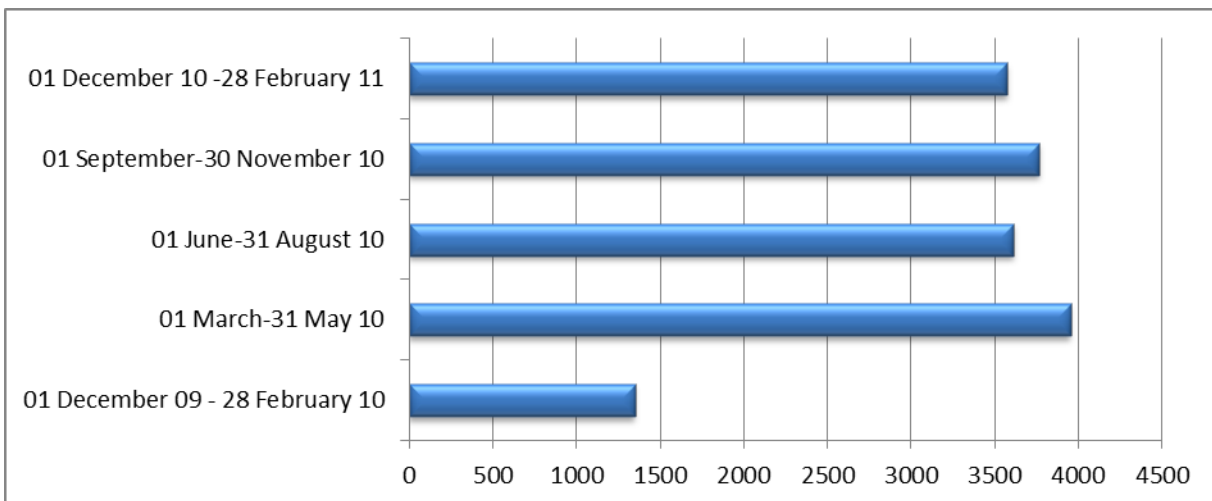


Figure 1 - Total Website Visits Year 2

The number of unique visits is 7946, as illustrated in the figure below with a peak between September and November 2010 where there was a high concentration of event promotion though the number of unique visitors building on the momentum gained in June 2010 when event promotional campaigns primarily focused on the 2nd DL.org Workshop and Autumn School.

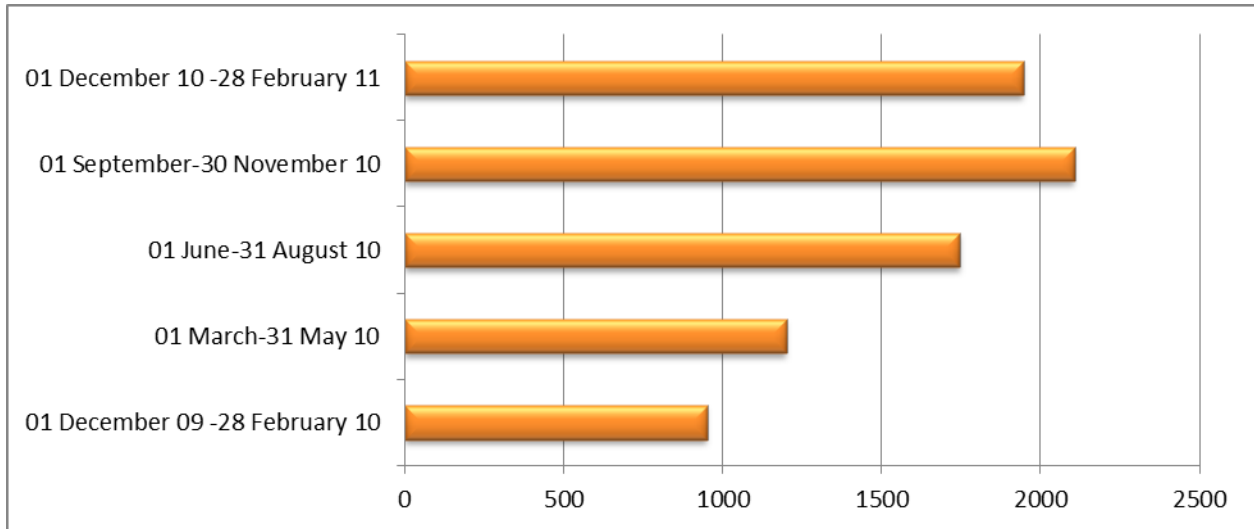


Figure 2 - Unique visits Year 2

The graphs below present navigation trends in terms of total page views, average time on the site and average page views per visit.

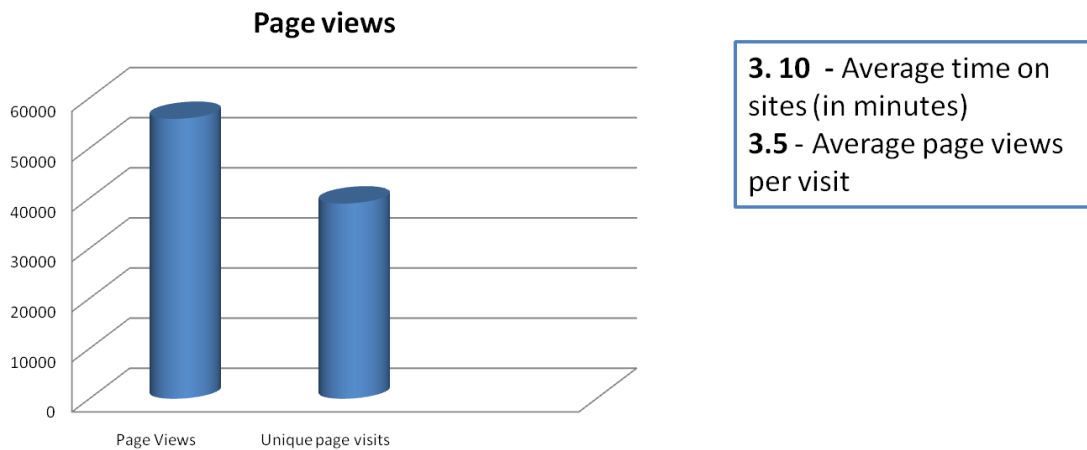


Figure 3 - Page views and average page views/visit

The following graphs serve to illustrate important outcomes for the second year of the project by comparing them with the first year in terms of total visits and country spread.

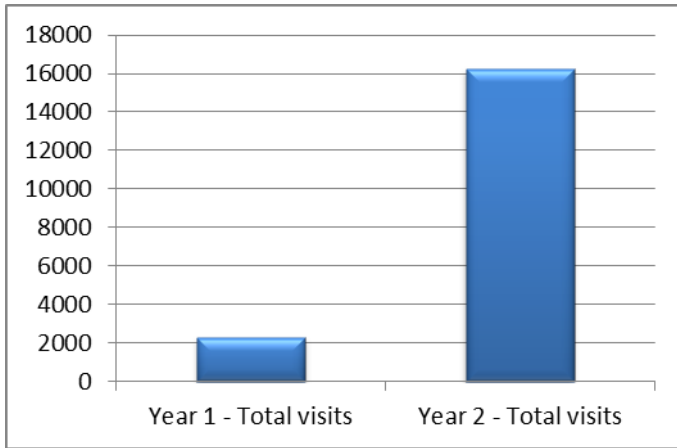


Figure 5 - Country spread Year 1 & 2

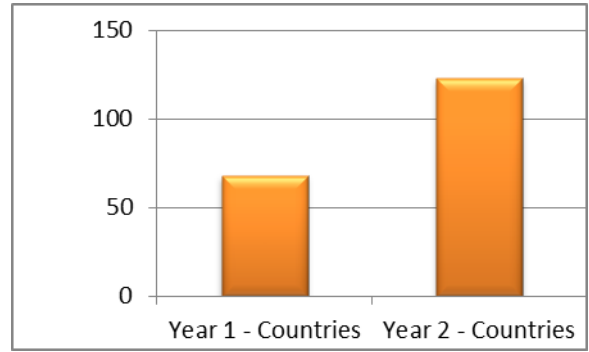


Figure 4 - Total Visits Year 1 & 2

Downloads of the Reference Model have increased in the second year from 156 in the first year to 275 in the second year, as shown in the graph below, whereas almost 200 downloads of the Cookbook have occurred in year two.

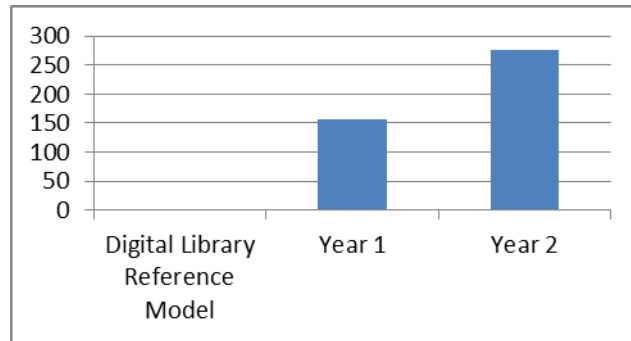
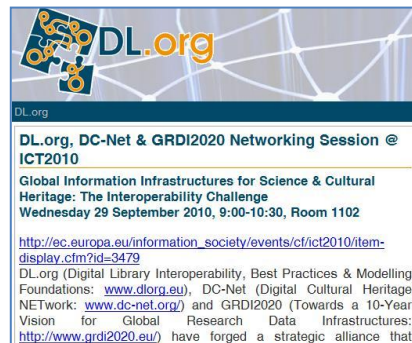


Figure 6 - Reference Model Downloads in Year 1 & 2

Project branding & Multimodal Content

The DL.org branding is well-established through the project website, fliers and promotional material, eNewsletters and eAnnouncements, the Virtual Goody Bags and Reading Lists and the project blog. A sample of the project branding is illustrated in the images below.



The project website comprises over 650 pages that have been created and updated with multimodal content, spanning blog postings, recorded lectures and round table debates.

Expert View – Antonella De Robbio on Organisational Interoperability

August 12th, 2010

In *Digital Libraries* (M.I.T. Press, January 2000 – rev.ed June 2005), William Arms defines Interoperability (IOP) as “the task of building coherent services for users when the individual components are technically different and managed by different organizations”.

In other words, Arms sees the problems of getting a wide variety of computing systems to work together as a fundamental challenge to all the aspects of digital libraries. In its complete form, interoperability would be synonymous with the seamless integration of disparate collections held by different organizations. I believe that this outlines very well organizational interoperability.

Christine Borgman (*From Gutenberg to the Global Information Infrastructure: Access to Information in the Networked World*, Cambridge, MA: The MIT Press, 2000) identifies three main aspects, relevant for digital libraries, relating to interoperability:



Expert View - Antonella De Robbio

A Round-table with

Kevin Ashley - Director of the DigitalCuration Centre, UK
 &
Yannis Ioannidis - Professor at the Department of Informatics and Telecommunications, University of Athens, Greece
 &
Seamus Ross - Dean of the Faculty of Informatics, University of Toronto, Canada



All DL.org outputs are available for free download on the project’s website.

Key dissemination outcomes been reported in detail in “D5.3b Dissemination and Training Report”, available on the DL.org website under On-line Media Room (<http://www.dlorg.eu/index.php/on-line-media-room>), as well as on the home page (<http://www.dlorg.eu/>) in the box dedicated to Events and Training.

2.5.3 Exploitation

The exploitation efforts were based on an approach established in the first year of the project, and which defines three levels for the exploitation strategy: the scientific, the educational and the knowledge transfer level. Targeted activities were addressed all three levels. The meetings and workshops organised, dealt with demanding research issues related to Digital Libraries interoperability and facilitated a structured scientific exchange on the topic. The same holds for the papers and presentations prepared by the consortium members and the members of the Working Groups, which tackled different aspects of Digital Libraries interoperability. Efforts were also intensified in order to throw into sharp relief the educational dimension, especially of the Digital Libraries Reference Model. For this reason dedicated events have been organised, even in the framework of Master Programmes with special emphasis on students as the next generation of developers and providers. Moreover, the Reference Model has served as the basis for DL.org's contribution to the Wikiversity learning material on Digital Libraries which is online available. Finally, the project partners and the members of the Working Groups have acted as mediators by disseminating and transferring knowledge created within the project to application and user communities in the field of DLs.

2.5.4 Sustainability

The sustainability of the DL.org outcomes is ensured through the exploitation of its main “products”, namely the Digital Libraries Reference Model, the Technology and Methodology Cookbook and the Digital Libraries Conformance Checklist. A number of actions is already planned to take place, so as to give concrete shape to the DL.org Business plan and, in parallel, well establish these products within the Digital Libraries community:

- A Tutorial on *Digital Libraries Foundation and Interoperability* will be organised in the frame of the Extended Semantic Web Conference 2011 (ESWC 2011);
- A Workshop on *Research and Education in Digital Libraries* will be organised in the frame of the European Library Automation Group Conference (ELAG 2011);
- The DL.org eTraining courses will be maintained;
- The collaboration with the Digital Libraries Curriculum Development Initiative will be continued;
- The DL.org web-portal will be maintained and updated as one-stop-shop for acquiring information about Digital Libraries, by offering multimodal resources (talks on the Reference Model and the Cookbook, and video resources from DL.org educational events), virtual reading lists, and access to Wikiversity and DL.org eTraining.

An effort will be undertaken, so as to sustain the patterns developed during the lifetime of the project for engaging people. In particular, the working groups proved to be a demanding, yet very creative tool for building a global research community and receiving input on open research issues. This structure can serve as a model and can also be adopted by new projects in which the partners will participate in the future. It is, however of utmost importance for DL.org to secure the partnerships and collaborations already established. The Memorandums of Understanding signed with several projects and organisations will allow this collaboration to continue and, hopefully, expand to new areas. Therefore, the actions described above will be complemented by the efforts to sustain the

networks of people which are already in place.

In this light, the links that already have been established with the Open Access Community (during the DL.org London workshop and the participation to the Open Access Conferences in Madrid and Athens) will be maintained and intensified, through the promotion of the DL.org products. The same applies to all other communities, projects and initiatives with which DL.org engaged during the lifespan of the project: the members of the Working Groups and the External Advisory Board, the Digital Libraries Curriculum Development Initiative, the Veria Central Library, the DILL International Master Program, all other DLs University Departments etc.

2.6 Use and dissemination of foreground

Section A (public)

This section includes two templates

- Template A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- Template A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

These tables are cumulative, which means that they should always show all publications and activities from the beginning until after the end of the project. Updates are possible at any time.

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
NO.	Title	Main author(s)	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers ⁴ (if available)	Is/Will open access ⁵ provided to this publication?
1	<i>Proceedings of the Second DL.org Workshop on Making DLs Interoperable: Challenges & Approaches</i>	D. Castelli, Y. Ioannidis, S. Ross (eds.)	<i>Lecture Notes in Computer Science (LNCS)</i>		<i>Springer</i>		<i>2011</i>			

⁴ A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

⁵ Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

	(MDLI2010)								
2	<i>Paving the Way for Digital Library Interoperability: The DL.org Project</i>	<i>K. El Raheb et al.</i>	<i>Proceedings of the 2nd International Conference on Qualitative and Quantitative Methods in Libraries (QQML2010)</i>		<i>World Scientific</i>		2011		
3	<i>A Framework for Digital Library Function Description, Publication, and Discovery: A prerequisite for interoperable digital libraries</i>	<i>G. Athanasopoulos, K. El Raheb, et al.</i>	<i>Lecture Notes in Computer Science (LNCS)</i>		<i>Springer</i>		2011		
4	<i>Modelling User and Context in Digital Libraries: Interoperability Issues</i>	<i>A. Nika et al.</i>	<i>Lecture Notes in Computer Science (LNCS)</i>		<i>Springer</i>		2011		
5	<i>Towards an Holistic Approach to Policy Interoperability in Digital Libraries</i>	<i>P. Innocenti, S. Ross, et al.</i>	<i>International Journal of Digital Curation</i>	<i>Vol. 5, no. 2</i>	<i>UKOLN / DCC</i>		2011		<i>ISSN 1746-8256</i>
6	<i>Quality interoperability within digital libraries: the DL.org perspective</i>	<i>G. Vullo et al.</i>	<i>Lecture Notes in Computer Science (LNCS)</i>		<i>Springer</i>		2011		
7	<i>DL.org Workshop on Digital Libraries, Open Access and Interoperability Strategies</i>	<i>S. Parker, G. Vullo</i>	<i>ERCIM News</i>				2011		<i>ISSN 0926-4981</i>
8	<i>Pre-proceedings of the 2nd DL.org Workshop - Making Digital Libraries Interoperable: Challenges and Approaches</i>	<i>D. Castelli, Y. Ioannidis, S. Ross (eds.)</i>			<i>DL.org</i>		2010		<i>ISBN 978-88628014-0</i>
9	<i>Building Large Heterogeneous Interconnected Digital Library Infrastructures: The Interoperability Challenge</i>	<i>L. Candela, D. Castelli, C. Thanos</i>	<i>EuroMed 2010 Conference</i>						
10	<i>Making Digital Library Content Interoperable</i>	<i>L. Candela, D. Castelli, C. Thanos</i>	<i>IRCDL 2010</i>						
11	<i>An Event-centric Provenance Model for Digital Libraries</i>	<i>D. Castelli et al.</i>	<i>IRCDL 2010</i>						

12	<i>Towards Global Data Interoperability</i>	L. Candela, D. Castelli, C. Thanos	CODATA 2010							
13	<i>A Functionality Perspective on Digital Library Interoperability</i>	G. Athanasopoulos et al.	<i>Lecture Notes in Computer Science (LNCS), Proceedings of ECCL2010</i>		Springer		2010			
14	<i>A Survey of Context-Aware Cross-Digital Library Personalisation</i>	A. Nika et al.	AMR2010				2010			
15	<i>User-Centric Perspective on Digital Library Interoperability</i>	A. Nika et al.	<i>Newsletter of the International Federation of Library Associations and Institutions</i>				July 2010			
16	<i>Towards a Digital Library Policy and Quality Interoperability Framework: the DL.org Project</i>	P. Innocenti et al.	<i>New Review of Information Networking (NRIN)</i>	Vol. 15, Issue 1	Routledge		May 2010	pp. 29-53	ISSN 1361-4576	
17	<i>Interoperability for Digital repositories: towards a policy and quality framework</i>	G. Vullo, P. Innocenti, and S. Ross	OR2010 Conference				2010			
18	<i>A global approach to DL evaluation</i>	G. Vullo	<i>LIBER Quarterly</i>	Volume 20, Issue 2			2010		ISSN 1435-5205	
19	<i>Towards Policy and Quality Interoperability: Challenges and Approaches for Digital Libraries</i>	G. Vullo, P. Innocenti, and S. Ross	<i>IS&T Archiving 2010 Preservation Strategies and Imaging Technologies for Cultural Heritage Institutions and Memory Organisations Conference Proceedings</i>		Society for Imaging Science and Technology		2010	pp. 33-38	ISBN 978-0-89208-290-2	
20	<i>Policy & Quality Interoperability: an organisational approach for digital archives and digital libraries</i>	P. Innocenti, G. Vullo, and S. Ross	<i>Abstract book of the 8th European Conference on Digital Archives</i>							

21	<i>Report on the First DL.org Workshop on Digital Library Interoperability, Best Practices and Modelling Foundations</i>	<i>P. Innocenti, E. Toli, L. Candela</i>	<i>D-Lib Magazine</i>	<i>Vol. 15, no. 11-12</i>			2009		<i>ISSN 1082-9873</i>	
----	--	--	-----------------------	---------------------------	--	--	------	--	-----------------------	--

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities ⁶	Main leader	Title	Date	Place	Type of audience ⁷	Size of audience	Countries addressed
1	Conference	GU	<i>8th European Conference on Digital Archiving Open Access : Research, Education , and Public Data</i>	<i>28-30 April 2010</i>	<i>Geneva, CH</i>	<i>Librarians, Archivists, LIS Researchers, Students and PhD candidates Computer Science and DL Community</i>		<i>EU</i>
2	Conference	<i>NKUA, GU</i>	<i>2nd International Conference on Qualitative and Quantitative Methods in Libraries (QQML2010)</i>	<i>25-28 May 2010</i>	<i>Chania, GR</i>	<i>Librarians, LIS Researchers, Students and PhD candidates</i>		<i>EU</i>
3	Conference	GU	<i>IS&T Archiving 2010 Preservation</i>	<i>1-4 June 2010</i>	<i>The Hague, NL</i>	<i>Digital Archiving Community,</i>		<i>EU</i>

⁶ A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

⁷ A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias ('multiple choices' is possible).

			<i>Strategies and Imaging Technologies for Cultural Heritage Institutions and Memory Organisations</i>			<i>Archivists, Librarians, Digital Archiving Researchers and PhD candidates</i>	
4	Conference	GU	<i>LIBER 2010</i>	<i>29 June-2 July 2010</i>	<i>Aarhus, DK</i>	<i>Library Managers, Librarians, Archivists, LIS Researchers and PhD candidates</i>	<i>EU</i>
5	Conference	<i>GU, NKUA, CNR</i>	<i>Open Repositories Conference (OR2010)</i>	<i>6-9 July 2010</i>	<i>Madrid, ES</i>	<i>Institutional Repositories Managers, Project Managers, Computer Science and DL Community, Librarians, LIS Researchers, Students and PhD candidates</i>	<i>EU</i>
6	Conference	<i>NKUA, GU, CNR</i>	<i>ECDL2010</i>	<i>6-10 September 2010</i>	<i>Glasgow, UK</i>	<i>Computer Science and DL Community, Institutional Repositories Managers, Project Managers, Librarians, Archivists, LIS Researchers, Students and PhD candidates</i>	<i>EU</i>
7	Conference	<i>NKUA</i>	<i>Europeana in Greece: Adding</i>	<i>19 October 2010</i>	<i>Athens, GR</i>	<i>Librarians, DL Researchers</i>	<i>Greece</i>

			<i>Greek Cultural Content to the European Digital Library</i>			<i>and PhD candidates</i>		
8	<i>Conference</i>	<i>GU</i>	<i>6th International Digital Curation Conference - DCC 2010</i>	<i>6-8 December 2010</i>	<i>Chicago, US</i>	<i>Institutional Repositories Managers, Project Managers, Librarians, Archivists, LIS Researchers, Students and PhD candidates</i>		<i>International</i>
9	<i>Conference</i>	<i>NKUA</i>	<i>Open Access: Research, Education, and Public Data</i>	<i>16-17 December 2010</i>	<i>Athens, GR</i>	<i>Computer Science and DL Community</i>		<i>Greece / EU</i>
10	<i>Fliers</i>	<i>Trust-IT</i>	<i>Six project fliers plus an Autumn School flier</i>	<i>January 2010 – February 2011</i>	<i>Conferences 1-7 & 9</i>	<i>Archivists, LIS, researchers, PhD candidates, computer scientists</i>	<i>500 produced, 480 circulated</i>	<i>Denmark, Greece, Netherlands, Spain, Switzerland, UK with international audiences</i>
11	<i>Posters</i>	<i>Trust-IT</i>	<i>2 project posters</i>	<i>December 2009 and October 2010</i>	<i>Cultural Heritage Online, December 2009 and EuroMED, November 2010</i>	<i>Humanities community, LIS, researchers</i>	<i>Poster display at 2 events in dedicated area</i>	<i>Italy and Cyprus with international audiences</i>
12	<i>Press Release</i>	<i>Trust-IT</i>	<i>Autumn School press release,</i>	<i>July and September 2010 (circulated by partners over monthly period)</i>	<i>Pisa – Italy;</i>	<i>LIS, PhD, researchers, national libraries EU27</i>	<i>8 clippings</i>	<i>EU</i>
13	<i>Press Release</i>	<i>Trust-IT</i>	<i>ICT2010 Networking Session</i>	<i>29 September 2010</i>	<i>Brussels - Belgium</i>	<i>Policy makers, trade & technology press</i>	<i>2 clippings (Web Science Magazine,</i>	<i>EU, international</i>

							Supercomputing Online)	
14	Press Release: event announcement	Trust-IT	Parma Seminar	20 October 2010	Pisa - Italy	International Science Grid This Week community	Event announcement on iSGTW	EU, international
15	Press release: event announcement	UA	Athens Workshop	November 2010	Athens - Greece	LIS, IT	9 clippings in Greek channels	Greece
16	Press release: event announcement	UG, Trust-IT	London Workshop	December 2010	Glasgow – Scotland; Pisa - Italy	LIS, research	10 clippings mainly in EU channels	EU, international
17	Interview	Trust-IT	Tobias Blanke, Kings College London and DARIAH	March 2010	Virtual	Humanities & ESFRI community	Interview also published on DARIAH, GRDI2020 websites	EU, international
18	Interview	Trust-IT	Wolfram Horstmann, Bielefeld University Library and OpenAIRE	July 2010	Virtual	Repository community	Project website & eNewsletter	EU
19	Interview	Trust-IT	Anna Maria Tamaro, University of Parma & DILL National Coordinator	November 2010	Virtual	LIS, master students	Project website. DILL & its master students	EU, international
20	Interview	Trust-IT	Marcial Batiandila, DILL Master Student	November 2010	Virtual	LIS, master students	Project website, eNewsletter, DILL & its master students	EU, international
21	Interview	Trust-IT	Heather Joseph, SPARC	March 2011	Virtual	Open Access Repository community	Project website, eNewsletter	EU, international
22	Round Table video	UA	Kevin Ashley, Yannis Ioannidis, Seamus Ross	October 2010	Athens, Greece	LIS, computer science, policy-makers	Project website	EU, international
23	Round Table video	CNR-ISTI	Parma Seminar Round Table participants	November 2010	Parma, Italy	LIS community	Project website	EU, international

24	<i>Filmed lectures/presentations</i>	<i>CNR-ISTE</i>	<i>Parma Seminar</i>	<i>November 2010</i>	<i>Parma, Italy</i>	<i>LIS community</i>	<i>Project website</i>	<i>EU, international</i>
----	--------------------------------------	-----------------	----------------------	----------------------	---------------------	----------------------	------------------------	--------------------------

Section B (Confidential or public: confidential information to be marked clearly)

Part B1

Not Applicable

Part B2

Not Applicable

2.7 Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

2.8

- **A General Information** (completed automatically when *Grant Agreement number* is entered).

Grant Agreement Number:	231551
Title of Project:	DL.org: Coordination Action on Digital Library Interoperability, Best Practices, and Modeling Foundations
Name and Title of Coordinator:	Dr. Donatella Castelli

- **B Ethics**

1. Did your project undergo an Ethics Review (and/or Screening)? <ul style="list-style-type: none"> • If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? <p>Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 'Work Progress and Achievements'</p>	<i>No</i>
2. Please indicate whether your project involved any of the following issues (tick box) :	YES
RESEARCH ON HUMANS	
• Did the project involve children?	
• Did the project involve patients?	
• Did the project involve persons not able to give consent?	
• Did the project involve adult healthy volunteers?	
• Did the project involve Human genetic material?	
• Did the project involve Human biological samples?	
• Did the project involve Human data collection?	
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	
• Did the project involve Human Foetal Tissue / Cells?	
• Did the project involve Human Embryonic Stem Cells (hESCs)?	
• Did the project on human Embryonic Stem Cells involve cells in culture?	
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
• Did the project involve tracking the location or observation of people?	

RESEARCH ON ANIMALS		
• Did the project involve research on animals?		
• Were those animals transgenic small laboratory animals?		
• Were those animals transgenic farm animals?		
• Were those animals cloned farm animals?		
• Were those animals non-human primates?		
RESEARCH INVOLVING DEVELOPING COUNTRIES		
• Did the project involve the use of local resources (genetic, animal, plant etc)?		
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?		
DUAL USE		
• Research having direct military use		0 Yes 0 No
• Research having the potential for terrorist abuse		
• C Workforce Statistics		
3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).		
Type of Position	Number of Women	Number of Men
Scientific Coordinator	1	
Work package leaders	3	3
Experienced researchers (i.e. PhD holders)		
PhD Students		
Other		
4. How many additional researchers (in companies and universities) were recruited specifically for this project?		
Of which, indicate the number of men:		

• D Gender Aspects		
5. Did you carry out specific Gender Equality Actions under the project?	<input type="radio"/> <input type="radio"/>	Yes No
6. Which of the following actions did you carry out and how effective were they?		
	Not at all effective	Very effective
<input type="checkbox"/> Design and implement an equal opportunity policy	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
<input type="checkbox"/> Set targets to achieve a gender balance in the workforce	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
<input type="checkbox"/> Organise conferences and workshops on gender	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
<input type="checkbox"/> Actions to improve work-life balance	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
<input type="radio"/> Other: <input style="width: 200px;" type="text"/>		
7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?		
<input type="radio"/> Yes- please specify	<input style="width: 150px;" type="text"/>	
<input type="radio"/> No		
• E Synergies with Science Education		
8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?		
<input type="radio"/> Yes- please specify	<input style="width: 150px;" type="text"/>	
<input type="radio"/> No		
9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?		
<input type="radio"/> Yes- please specify	<input style="width: 150px;" type="text"/>	
<input type="radio"/> No		
• F Interdisciplinarity		
10. Which disciplines (see list below) are involved in your project?		
<input type="radio"/> Main discipline ⁸ :		
<input type="radio"/> Associated discipline ⁸ :	<input type="radio"/>	Associated discipline ⁸ :
• G Engaging with Civil society and policy makers		
11a Did your project engage with societal actors beyond the research community? (if 'No', go to Question 14)	<input type="radio"/> <input type="radio"/>	Yes No
11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?		
<input type="radio"/> No		
<input type="radio"/> Yes- in determining what research should be performed		
<input type="radio"/> Yes - in implementing the research		
<input type="radio"/> Yes, in communicating /disseminating / using the results of the project		

⁸ Insert number from list below (Frascati Manual).

11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	<input type="radio"/> <input type="radio"/>	Yes No
12. Did you engage with government / public bodies or policy makers (including international organisations)		
<input type="radio"/> No <input type="radio"/> Yes- in framing the research agenda <input type="radio"/> Yes - in implementing the research agenda <input type="radio"/> Yes, in communicating /disseminating / using the results of the project		
13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers? <input type="radio"/> Yes – as a primary objective (please indicate areas below- multiple answers possible) <input type="radio"/> Yes – as a secondary objective (please indicate areas below - multiple answer possible) <input type="radio"/> No		
13b If Yes, in which fields?		
Agriculture Audiovisual and Media Budget Competition Consumers Culture Customs Development Economic and Monetary Affairs Education, Training, Youth Employment and Social Affairs	Energy Enlargement Enterprise Environment External Relations External Trade Fisheries and Maritime Affairs Food Safety Foreign and Security Policy Fraud Humanitarian aid	Human rights Information Society Institutional affairs Internal Market Justice, freedom and security Public Health Regional Policy Research and Innovation Space Taxation Transport

13c If Yes, at which level? <input type="radio"/> Local / regional levels <input type="radio"/> National level <input type="radio"/> European level <input type="radio"/> International level		
• H Use and dissemination		
14. How many Articles were published/accepted for publication in peer-reviewed journals?		
To how many of these is open access⁹ provided?		
How many of these are published in open access journals?		
How many of these are published in open repositories?		
To how many of these is open access not provided?		
Please check all applicable reasons for not providing open access:		
<input type="checkbox"/> publisher's licensing agreement would not permit publishing in a repository <input type="checkbox"/> no suitable repository available <input type="checkbox"/> no suitable open access journal available <input type="checkbox"/> no funds available to publish in an open access journal <input type="checkbox"/> lack of time and resources <input type="checkbox"/> lack of information on open access <input type="checkbox"/> other ¹⁰ :		
15. How many new patent applications ('priority filings') have been made? <i>("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).</i>		
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	
	Registered design	
	Other	
17. How many spin-off companies were created / are planned as a direct result of the project?		
<i>Indicate the approximate number of additional jobs in these companies:</i>		
18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:		
<input type="checkbox"/> Increase in employment, or <input type="checkbox"/> Safeguard employment, or <input type="checkbox"/> Decrease in employment, <input type="checkbox"/> Difficult to estimate / not possible to quantify	<input type="checkbox"/> In small & medium-sized enterprises <input type="checkbox"/> In large companies <input type="checkbox"/> None of the above / not relevant to the project	

⁹ Open Access is defined as free of charge access for anyone via Internet.

¹⁰ For instance: classification for security project.

<p>19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (FTE = one person working fulltime for a year) jobs:</p> <p>Difficult to estimate / not possible to quantify</p>	<p><i>Indicate figure:</i></p> <p><input type="checkbox"/></p>		
<p>• I Media and Communication to the general public</p>			
<p>20. As part of the project, were any of the beneficiaries professionals in communication or media relations?</p> <p><input type="radio"/> Yes <input type="radio"/> No</p>			
<p>21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?</p> <p><input type="radio"/> Yes <input type="radio"/> No</p>			
<p>22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Press Release <input type="checkbox"/> Media briefing <input type="checkbox"/> TV coverage / report <input type="checkbox"/> Radio coverage / report <input type="checkbox"/> Brochures /posters / flyers <input type="checkbox"/> DVD /Film /Multimedia </td> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Coverage in specialist press <input type="checkbox"/> Coverage in general (non-specialist) press <input type="checkbox"/> Coverage in national press <input type="checkbox"/> Coverage in international press <input type="checkbox"/> Website for the general public / internet <input type="checkbox"/> Event targeting general public (festival, conference, exhibition, science café) </td> </tr> </table>		<input type="checkbox"/> Press Release <input type="checkbox"/> Media briefing <input type="checkbox"/> TV coverage / report <input type="checkbox"/> Radio coverage / report <input type="checkbox"/> Brochures /posters / flyers <input type="checkbox"/> DVD /Film /Multimedia	<input type="checkbox"/> Coverage in specialist press <input type="checkbox"/> Coverage in general (non-specialist) press <input type="checkbox"/> Coverage in national press <input type="checkbox"/> Coverage in international press <input type="checkbox"/> Website for the general public / internet <input type="checkbox"/> Event targeting general public (festival, conference, exhibition, science café)
<input type="checkbox"/> Press Release <input type="checkbox"/> Media briefing <input type="checkbox"/> TV coverage / report <input type="checkbox"/> Radio coverage / report <input type="checkbox"/> Brochures /posters / flyers <input type="checkbox"/> DVD /Film /Multimedia	<input type="checkbox"/> Coverage in specialist press <input type="checkbox"/> Coverage in general (non-specialist) press <input type="checkbox"/> Coverage in national press <input type="checkbox"/> Coverage in international press <input type="checkbox"/> Website for the general public / internet <input type="checkbox"/> Event targeting general public (festival, conference, exhibition, science café)		
<p>23 In which languages are the information products for the general public produced?</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> Language of the coordinator <input type="checkbox"/> Other language(s) </td> <td style="width: 50%; vertical-align: top;"> <input type="checkbox"/> English </td> </tr> </table>		<input type="checkbox"/> Language of the coordinator <input type="checkbox"/> Other language(s)	<input type="checkbox"/> English
<input type="checkbox"/> Language of the coordinator <input type="checkbox"/> Other language(s)	<input type="checkbox"/> English		

Question F-10: Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES

- 1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]
- 1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)
- 1.3 Chemical sciences (chemistry, other allied subjects)
- 1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)
- 1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2. ENGINEERING AND TECHNOLOGY

- 2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

- 2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]
- 2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

- 3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immuno-haematology, clinical chemistry, clinical microbiology, pathology)
- 3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)
- 3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

- 4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)
- 4.2 Veterinary medicine

5. SOCIAL SCIENCES

- 5.1 Psychology
- 5.2 Economics
- 5.3 Educational sciences (education and training and other allied subjects)
- 5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary, methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

- 6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)
- 6.2 Languages and literature (ancient and modern)
- 6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]